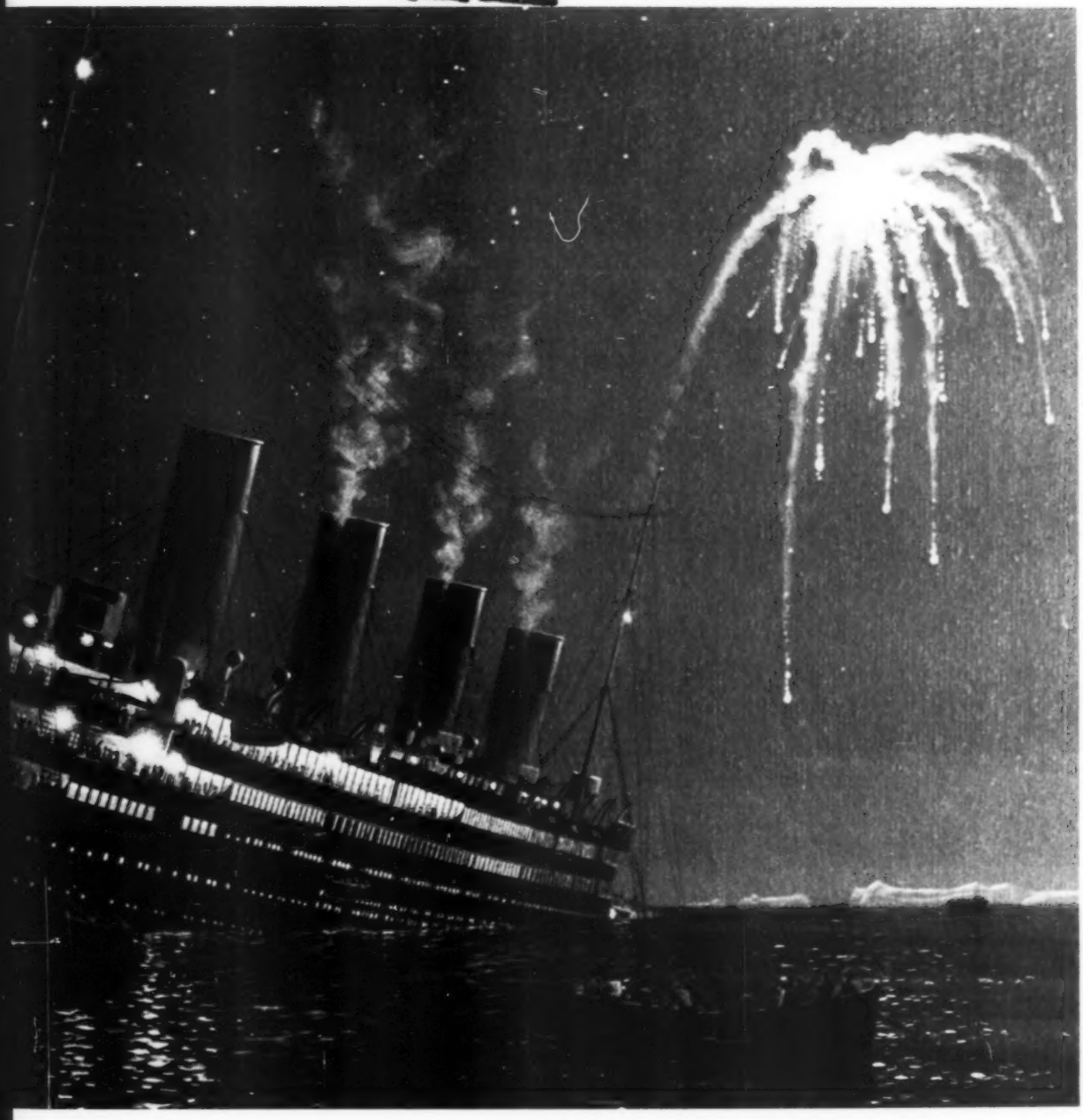
Spring 1989 • Vol. 33 , No. 2

Mariners Weather Log



- **The Hurricanes of 1988 — page 8**
- **Tribute to Lono, the sky god — page 22**

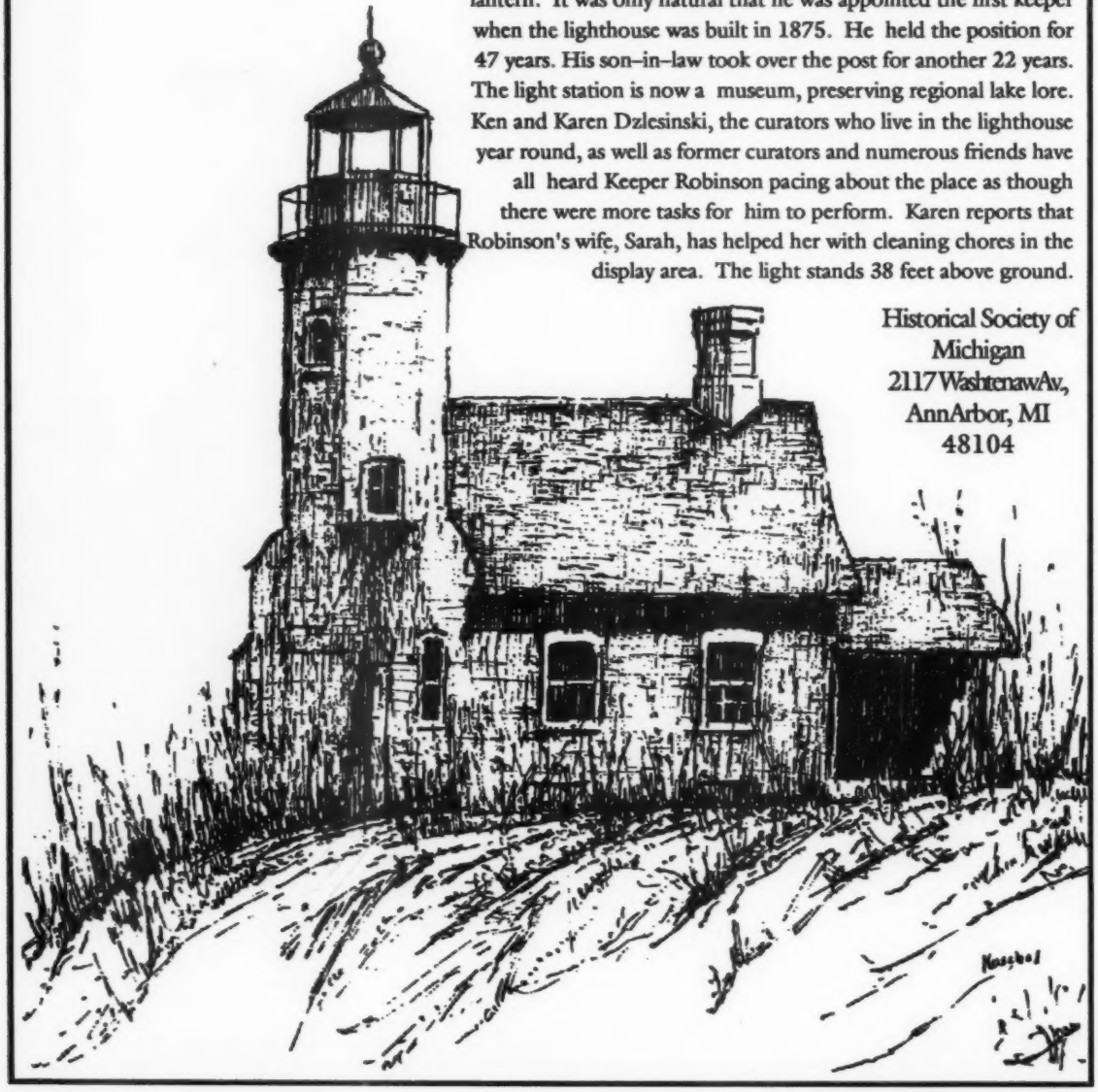
White River Light Station

Lake Michigan
North of Muskegon, MI.

Pen and ink drawings by Leo V. Kuschel
Descriptive passages by Leo and Sue Kuschel

This is a tale of dedication by a Great Lakes lighthouse keeper. William Robinson began his lighthouse–keeping career as a young boy, guiding ships into White River from Lake Michigan with a lantern. It was only natural that he was appointed the first keeper when the lighthouse was built in 1875. He held the position for 47 years. His son–in–law took over the post for another 22 years. The light station is now a museum, preserving regional lake lore. Ken and Karen Dzlesinski, the curators who live in the lighthouse year round, as well as former curators and numerous friends have all heard Keeper Robinson pacing about the place as though there were more tasks for him to perform. Karen reports that Robinson's wife, Sarah, has helped her with cleaning chores in the display area. The light stands 38 feet above ground.

Historical Society of Michigan
2117 Washtenaw Av,
Ann Arbor, MI
48104



Mariners Weather Log

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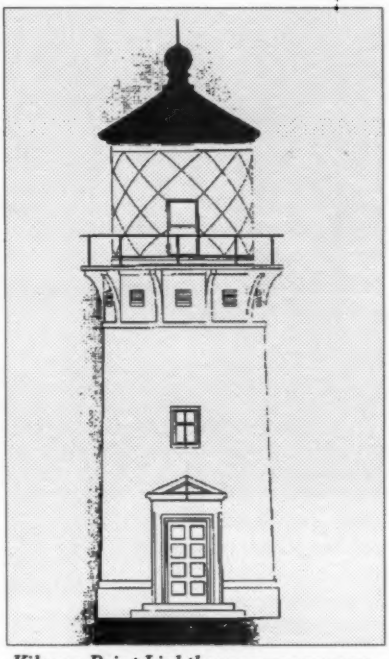
Features



Kilauea Point Lighthouse was once one of the Pacific Ocean's most powerful and needed navigational aids.

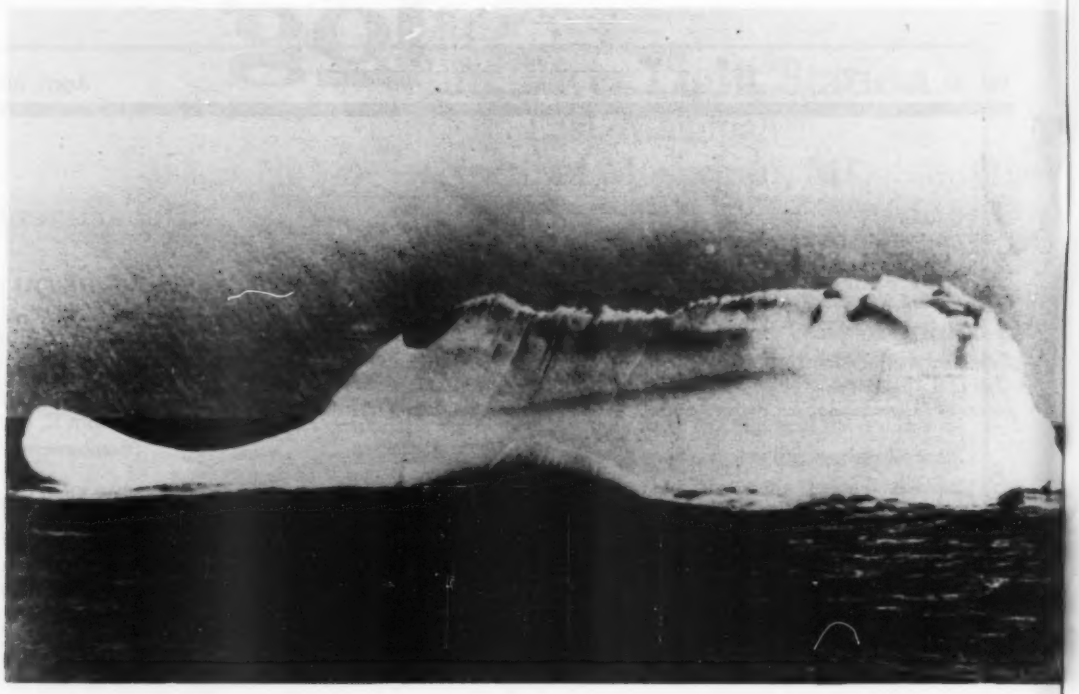
Departments

Marine Weather Review

Cover and back: The *End of an Era,* marked the beginning of another; its 75th anniversary is celebrated this year by the U.S. Coast Guard. This wonderful painting of the ***Titanic*** was done by Ken Marschall, whose work has appeared on the cover of Time magazine among other places. Ken operates Titanic Originals, 1031 Av. D, Redondo Beach, CA 90297.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through July 1, 1989.

The **Mariners Weather Log** (ISSN:0025–3367) is published quarterly by the **National Oceanographic Data Center,** National Environmental Satellite, Data, and Information Service, NOAA, Washington DC 20235 (telephone; 202–673–5571). Funding is provided by the **National Weather Service,** NOAA. Data is provided by the **National Climatic Data Center,** NOAA. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402. Articles and photographs (will be returned) should be sent to: Editor, Mariners Weather Log, National Oceanographic Data Center, Washington DC 20235.



Looking for Icebergs

Lt. Michael A. Alfultis
U.S. Coast Guard

The 1989 Ice Season marks the 75th year that the U.S. Coast Guard has been providing the International Ice Patrol in the North Atlantic.

The International Ice Patrol (IIP) got its start from one of the most famous incidents in maritime history. Books, movies and television have all told the story. The organization's history began when this message was received: "We are sinking fast passengers being put into boats." This was the last message received from the ***Titanic*** on that fateful, moonless April night of long ago. The loss of the RMS ***Titanic*** on April 15, 1912, when it struck an iceberg south of the Grand Banks of Newfoundland, triggered a public outcry from maritime nations on both sides of the Atlantic.

To prevent another such disaster, the United States, for the rest of 1912, used the U.S. Navy cruisers ***Chester*** and ***Birmingham*** to patrol the limits of ice danger and to warn passing ships. For 1913, the U.S. Revenue Cutter Service (forerunner of the Coast Guard) was requested to undertake the ice warning patrol. The unabated public pressure on the maritime governments led to the

*This is believed to be the iceberg that sank the Titanic on April 15, 1912. The photo was taken from the deck of the Western Union Cable Ship, **Mackay –Bennett**, commanded by Captain DeCarteret. According to DeCarteret this was the only berg at the scene of the sinking when he arrived. The vessel took aboard 100 coffins before steaming out of Halifax on April 17th. Over the next few days she picked up more than 300 bodies.*

*Below is the Revenue Cutter **Seneca**, the first vessel to undertake the International Ice Patrol.*

Below, right a Coast Guard HC–130 –B hedge–hops a row of icebergs off the Labrador coast.

Woods Hole Oceanographic Institution

Safety of Life at Sea (SOLAS) Convention of 1913 held in London. This meeting, attended by representatives of thirteen maritime nations, resulted in an unprecedented international agreement dealing with many aspects of the maritime industry. One section of the SOLAS called for the establishment of an international ice observation, and ice patrol service to patrol the limits of the ice danger in the southwestern, southern, and southeastern areas of the Grand Banks of Newfoundland, and to conduct research into the ice danger. The signatory countries would reimburse the government undertaking this service based on their shipping tonnage passing through this area. The U.S. government was asked to undertake this task. The SOLAS agreement was ratified in early 1914. Thus, it was the international maritime community which created the International Ice Patrol (IIP). On February 7, 1914, President Wilson directed the Secretary of Treasury to have the Revenue Cutter Service undertake the international ice observation and patrol service as soon as possible. The Cutters ***Seneca*** and ***Miami*** undertook the task that year. The U.S. Coast Guard has conducted the International Ice Patrol service since 1914, except for six war years— 1917, 1918, and 1942 through 1945.

The Ice Patrol Service was initially provided by Revenue Cutter Service Cutters conducting surface patrols and twice daily broadcasting the southern, southeastern, and southwestern limits of ice danger. With the advent of aerial reconnaissance in 1946, the need for surface patrols diminished. Only nine seasons between 1946 and 1980 required cutters to patrol the Grand Banks. Surface patrols were last used in 1980. Although having the ability to cover larger areas than surface patrols, visual aircraft reconnaissance was severely limited by the fog and poor visibility, which prevails over much of the Ice Patrol's region. In 1983, the Coast Guard installed a Side-Looking Airborne Radar (SLAR) system on its Hercules C-130 long range reconnaissance aircraft. This system allows IIP to detect surface targets (including icebergs) in all weather. This technology has enabled the IIP to reduce deployed resources by half during the ice season. Today there is an aerial Iceberg Reconnaissance Detachment (ICERECDET) consisting of a SLAR-equipped HC-130 aircraft and aircrews from Coast Guard Air Station Elizabeth City, North Carolina. With IIP ice observers it operates out of Newfoundland on an average of 7 days every 2 weeks. Even with SLAR, IIP still relies on international cooperation for reporting of icebergs. Each year, over 50% of all iceberg sighting reports come from other than IIP reconnaissance flights. Canada, with its own domestic ice patrol and coastal lighthouses, is a significant contributor. The ice patrol requests that ships sailing the Grand Banks report ice sightings to the International Ice Patrol Operations Center in Groton, CT. **International shipping is the leading contributor of iceberg sighting reports.**

Watchstanders at the IIP Operations Center analyze the iceberg sighting information from ICERECDET along with commercial shipping and Canadian iceberg sighting reports. Only those iceberg sightings within IIP's operations area are entered into IIP's iceberg drift and deterioration prediction computer model (ICEPLOT). The watchstanders determine whether the sighting is a new sighting of an iceberg already on ICEPLOT or whether it is a sighting of an iceberg, which had not been previously reported.

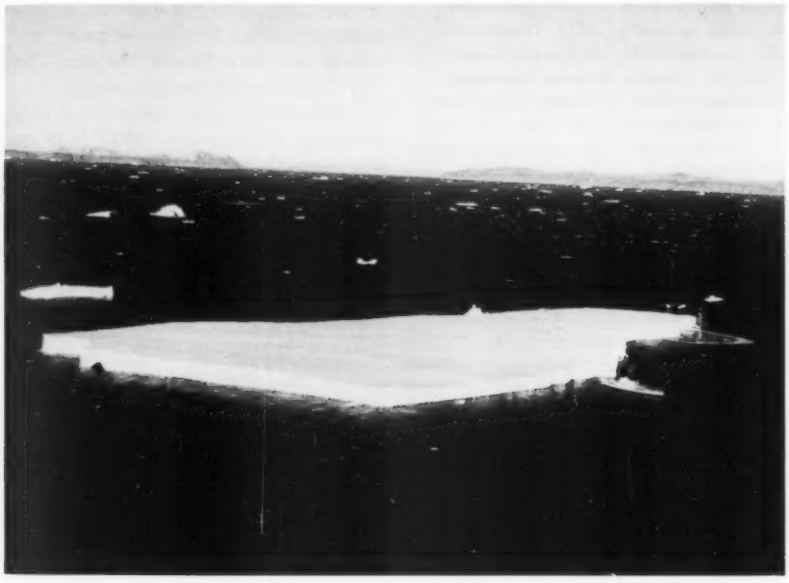
This data is fed into the computer model along with ocean current and environmental data. Using this information, the model predicts the drift and deterioration of each iceberg. Twice daily, the predicted positions are used to estimate the limit of all known ice. This limit, along with a few critical iceberg positions, is broadcast as an "Ice Bulletin" from radio stations in the United States, Canada, and Europe at 0000Z, for the benefit of all vessels sailing the North Atlantic. In addition, IIP prepares a facsimile chart, graphically depicting these limits, for transmission at 1600Z.

The International Ice Patrol has traditionally maintained counts on the number of icebergs crossing lati-

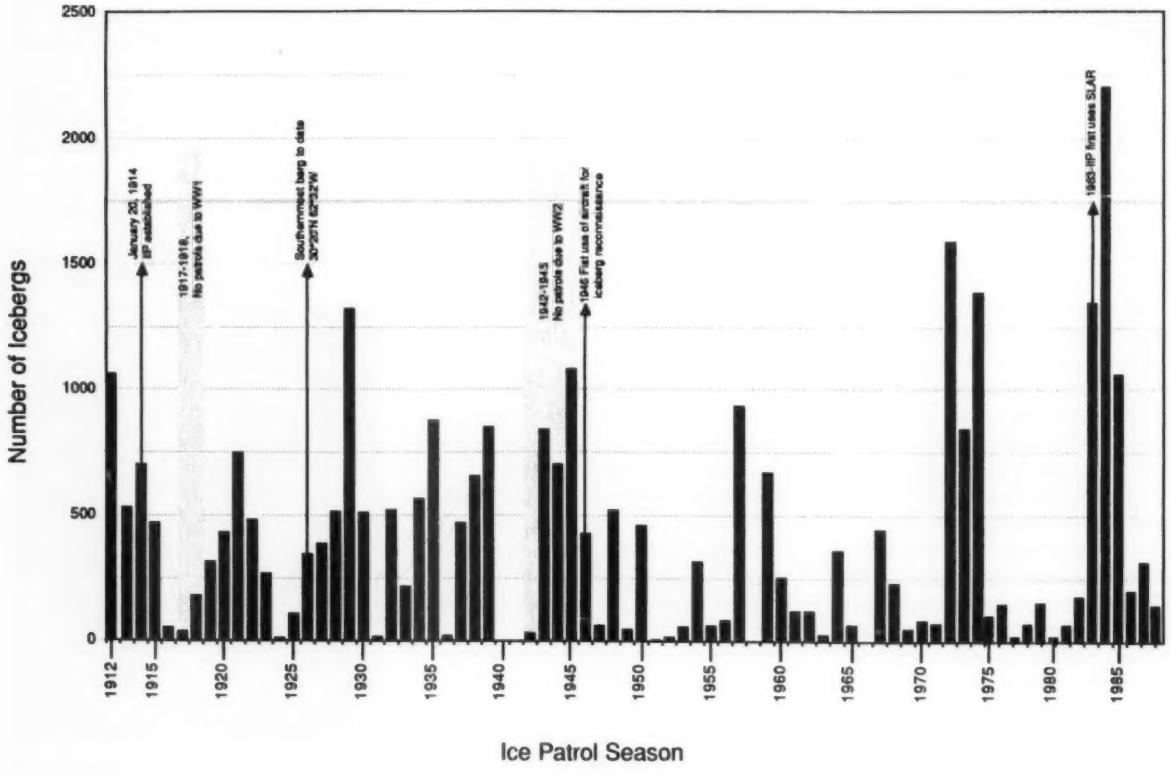
U. S. Coast Guard

tude 48°N. This number is used by IIP to gauge the potential threat to North Atlantic shipping. The variability in the record from year to year is related to several factors. These include the number of icebergs available to drift onto the Grand Banks, factors affecting iceberg transport (currents, winds, and sea ice), and conditions affecting deterioration (wave action, sea surface temperature, and sea ice). These factors are often unpredictable.

Since its inception, the International Ice Patrol has amassed an enviable safety record. Not a single reported loss of life of property due to a collision with an iceberg has occurred outside its limits of all known ice. However, the potential for a catastrophe still remains. In 1987, a fishing vessel struck an iceberg and sank inside the iceberg limits broadcast by IIP. Such instances continue to show the need for vigilance on the part of the mariner.



Number of Icebergs South of 48°N (1912-88)



Battling North Atlantic Icebergs

Icebergs, mainly from the glaciers of west Greenland, are carried southward to the waters of the Grand Banks by the cold Labrador Current. It is in this area where the Labrador Current converges with the significantly warmer waters of the Gulf Stream that sea water temperature differences of up to 20°C can exist. The formation of dense fog occurs up to 40 to 50 percent of the time. The combined threat of fog, icebergs, and severe North Atlantic storms, plus the concentration of trans-Atlantic shipping, fishing vessels, and oil platforms, makes the Grand Banks one of the most dangerous areas in the world for marine transportation.

Information concerning ice conditions is collected primarily from patrol surveillance flights, other aircraft, and ships operating in or passing through the waters of the Grand Banks. All shipping may assist in the operation of International Ice Patrol by reporting all sightings of ice at once to COMINTICEPAT GROTON, CT.
To report ice sightings send them through the U.S. Coast Guard Communication Stations. If unable to work these stations use the Canadian Coast Guard Station, St. John's/VON or any other Canadian Coast Guard Station.

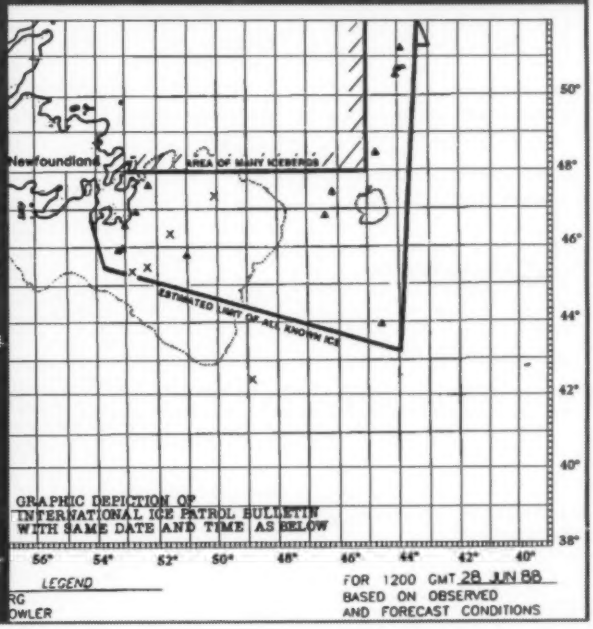
When reporting ice, please include the following information:
SHIP NAME AND CALL SIGN
POSITION (OF VESSEL OR ICE - SPECIFY)
TIME OF SIGHTING
SIGHTING METHOD (VISUAL OR RADAR)
SIZE AND SHAPE OF ICEBERG
CONCENTRATION OF ICE (FOR SEA ICE, IN TENTHS)
THICKNESS OF ICE (FOR SEA ICE, IN FEET OR METERS)

The following table can be used to help describe the icebergs:

	Size				Type		
Descriptive Name		Height		Length		Shape	Description
		(ft)	(m)	(ft)	(m)	Non-Tabular (N)	This category covers all icebergs that
Growler	(G)	<17	<5	<50	<15		are not tabular-shaped as described
Small Berg	(S)	17–50	5–15	50–200	15–60		below; includes bergs dome-shaped,
Medium Berg	(M)	51–150	16–45	201–400	61–122		sloping, blocky and pinnacle.
Large Berg	(L)	151–240	46–75	401–670	123–213	Tabular (T)	Flat topped icebergs with length
Very Large Berg	(V)	>240	>75	>670	>213		-height ratio >(greater than) 5:1.

Sample International Ice Patrol Bulletin and Facsimile Chart

UNCLAS //N16170//
SUBJ: INTERNATIONAL ICE PATROL (IIP) BULLETIN
1. 281200Z JUN 88 INTERNATIONAL ICE PATROL BULLETIN. REPORT ALL ICE SIGHTED TO COMINTICEPAT VIA CG COMMUNICATIONS STATION NMF, NMN AND ANY CANADIAN COAST GUARD RADIO STATION. ALL SHIPS ARE REQUESTED TO MAKE UNCLASSIFIED SEA SURFACE TEMPERATURE AND WEATHER REPORTS TO COMINTICEPAT EVERY SIX HOURS WHEN WITHIN THE LATITUDES OF 40N AND 52N AND LONGITUDES 39W AND 57W. IT IS NOT NECESSARY TO MAKE THESE REPORTS IF A ROUTINE WEATHER REPORT IS MADE TO METEO WASHINGTON D.C. ALL MARINERS ARE URGED TO USE EXTREME CAUTION WHEN TRANSITING NEAR THE GRAND BANKS SINCE OTHER ICE MAY BE IN THE AREA.
2. THE ICEBERG, GROWLER, AND RADAR TARGET POSITIONS ARE BASED ON ESTIMATED DRIFT. DATE OF SIGHTING IS IN PARENTHESIS FOLLOWING THE POSITION. ALL DATES ARE JUNE UNLESS OTHERWISE INDICATED.
3. ESTIMATED LIMITS OF ALL KNOWN ICE: CAPE ST MARY (4849N 5411W) TO 4530N 5345W TO 4315N 4355W TO 5115N 4320W TO 5200N 4320W THEN NORTHWARD.
4. SOUTHERN AND EASTERN MOST BERGS: 4357N 4434W(23), 4548N 5101W(23),
4556N 5313W(23), 4558N 5313W(23), 4636N 5300W(16), 4650N 4626W(21), 4656N 5240W(25), 4729N 4610W(21), 4739N 5241W(24), 4828N 4444W(22), 5031N 4402W(25), 5042N 4359W(25), 5115N 4351W(25).
5. GROWLERS ESTIMATED AT 5045N 4357W(25).
6. RADAR TARGETS ARE ESTIMATED AT 4522N 5249W(23), 4529N 5219W(23), 4622N 5135W(23), 4722N 5006W(23).
THE FOLLOWING RADAR TARGET IS OUTSIDE THE LIMITS OF ALL KNOWN ICE: 4230N 4850W(21).
7. THERE ARE MANY ICEBERGS AND GROWLERS NORTH OF 4800N AND WEST OF 4500W.
BT



International Ice Patrol Broadcasts

Broadcast Station	Time of Broadcast (UTC)	Frequencies (kHz)
NAVTEX Ice Broadcast C. G. Comm. Stn. Boston/ *NIK*	0445, 1045 1645, 2245	518
NBDP (FEC) Ice Broadcast C. G. Comm. Stn. Boston/ *NIK*	0018 1218	5320, 8502, 12750 8502, 12750
CW Broadcasts C. G. Comm. Stn. Boston/ *NIK* (follows NBDP broadcast)	0050 1250	5320, 8502, 12750 8502, 12750
Canadian CG Radio Stn. St. John's/ *VON*	0000 1400	478
Canadian Forces METOC Centre Halifax/ *CFH*	0014, 1101 1301, 1401 2201, 2301	122.5 (off air 1200–1600 2d Thurs. each month) 4271 Cont., 6330 Cont. 10536 Cont., 13510 Cont.
LCMP Broadcast Norfolk, VA *NMN/NAM/NAR/NRK/AOK/GXH/NGR*	0800–0900, 1500–1600 1600–1700, 2100–2200	8090 Cont., 12135 Cont. 16180 Cont., 20225 (1200–2359)
Thurso, Scotland/*GXH*	Same Times	7504.5 Cont., 12691 (0800–1900) 4001 (1900–0800)
Keflavik, Iceland/*NRK*	Same Times	5167 (1900–0800)
Key West, FL/*NAR*	Same Times	5870 Cont., 2675 (1200–2359)
Rota, Spain/*AOK*	Same Times	5917.5 Cont., 7705 Cont.
Nea Makri, Greece/*NGR*	Same Times	4623 Cont., 13372.5 (0800–1900)
Radiofacsimile Broadcasts C.G. Comm. Stn. Boston/*NIK*	1600	8502, 12750 (+/- 400Hz)
Can. Forces METOC Cen. Halifax/*CFH* (Primarily sea ice in Gulf of St. Lawrence and north. Iceberg limits sometimes given.	0014, 1101 1301, 1401 2201, 2301	122.5 Cont., (Off air 1200–1600 2d Thur. each month) 4271 Cont. 6330 Cont., 10536 Cont., 13510 Cont.
Radio Stn. Bracknell, U.K./*GFE* (Eastern N. Atlc Sea Ice Obs.)	1413	2618.5 (1800–0600, Oct. 1–Mar 31; 1900–0500, Apr. 1–Sep. 30) 4782 Cont. 9203 Cont., 14436 Cont., 18261 (0600– 1800, Oct 1–Mar. 31; 0500–1900 Apr. 1–Sep. 30)
Special Broadcasts Can. CG Radio Stn. St. John's/*VON*	As required when icebergs sighted outside ice limits between sched. broadcasts.	2598 Radiotelephone preceded by Int. Safety Signal (SECURITE) on 2182 kHz. 478 (CW)– preceded by Int. Safety Signal (TTT) on 500 kHz.
C.G. Comm. Stn Boston/*NIK*	As required when icebergs sighted outside ice limits between sched. broadcasts. NAVTEX upon receipt or first available window. NBDP (FEC) next sched. broadcast.	2670 Radiotelephone preceded by Int. Safety Signal (SECURITE) on 2182 kHz. 472 (CW) preceded by Int. Safety Signal (TTT) on 500 kHz.
International Ice Patrol Vessel/ *NIDK* (when assigned)	When in the vicinity of ice in periods of darkness or fog.	2670 preceded by Int. Safety Signal (SECURITE) on 2182 kHz.

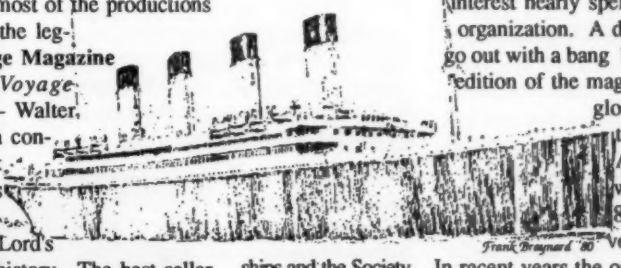
More on the Titanic

Following the sinking of the great White Star liner in 1912 a number of books were rushed into print by entreprenuers looking for a quick profit, often disregarding the facts of the tragedy. A few were more carefully prepared by survivors, providing a vivid recollection of what happened that fateful night. Once the various inquiries were over and the results published, the event was for the most part forgotten. Occasionally, a magazine article of a survivor's account or a novel, such as Robert Prechtl's *Titanic*, published in 1940, would surface to bring the incident briefly into the limelight. A British film, *Atlantic*, was produced in the late 1930's while a German propaganda film, entitled *Titanic* was made in 1948. Both stressed the tired old legends of a shipping company wanting to make a quick crossing of the Atlantic to capture the legendary Blue Riband and to satisfy wealthy American plutocrats, while third class or steerage passengers paid with their lives. There were also the short obituaries in local or national papers when a Titanic survivor would pass away.

In the 1950's a new era of Titanic–related events stirred new interest in the tragedy. In 1953, 20th Century–Fox released *Titanic*, originally titled *Nearer My God to Thee*. The picture won an Oscar for best screenplay. About the same time CBS Television began a new series narrated by Walter Cronkite. One show was titled: *April 15, 1912, The Sinking of the Titanic and You Are There*. While most of the productions were historically inaccurate, they kept the legend alive. In 1955 **American Heritage Magazine** published an article entitled *Maiden Voyage* introducing a fairly unknown author— Walter Lord. Readers Digest also presented a condensed version at the same time the book itself— *A Night To Remember*— was published and the tragedy of 1912 reached a new generation. Walter Lord's book opened the floodgates of Titanic history. The best seller was transformed into a Kraft Television Theatre presentation. The production was aired live and was so well received by viewers that it was rebroadcast to the public again a few weeks later in kinescope.

It was within the time frame of all these Titanic–related events that the seed was planted that would eventually become **The Titanic Historical Society**. Edward Kamuda was a school boy who became fascinated with the story through books and movies. Through correspondence, first with British film–makers and other enthusiasts, and then a survivor, his interest was nutured. After this survivor, Walter Belford, died and his possesions, including some artifacts from the ***Titanic***, were thrown away it was decided among the small group of ***Titanic*** historians that something had to be done to prevent this from happening again. On July 7, 1963 **The Titanic Enthusiasts of America** was born in Indian Orchard, MA, to investigate and perpetuate the memory and history of the ***Titanic*** and her sister ships, ***Olympic*** and ***Britannic***. The organization officially began on September 6, 1963 with six active (dues–paying) members and 45 Honor members. The Honor membership consisted mainly of ***Titanic*** survivors, whose names and addresses were published in an *Information Book* to be used by theatre managers who might book the film *A Night To Remember* and wish to contact a survivor for publicity. Each survivor listed in the book was contacted by Kamuda. By 1957 there were 83.

The first edition of the Society journal, **The Marconigram**, was soon produced in a newspaper format that totaled 100. The newsletter was well received by the membership but the name had to be changed because of an objection by the Marconi Company. The name was changed to **The Titanic Commutator**. A commutator is a device that measures the degree of list of a vessel and was one of the first instruments consulted by Captain Smith after the ***Titanic*** collided with the iceberg. The format changed to a magazine style, published quarterly. On September 17, 1966 the first membership meeting was held at the Seamen's Church Institute in New York. In attendance were two of the founding officers, three ***Titanic*** survivors and Walter Lord. Toward the end of 1967 a lull in ***Titanic*** interest nearly spelled the end for the organization. A decision was made to go out with a bang by producing a super edition of the magazine complete with glossy pages and a history of the ***Olympic***. A wealth of material was collected and the 80–page edition rejuvenated interest in the ships and the Society. In recent years the organization, renamed the **Titanic Historical Society** in 1975, has grown as has the interest in the ***Titanic***. Perhaps the biggest boost was the discovery of its location and subsequent underwater filming by Dr. Robert Ballard of Woods Hole Oceanographic Institution and the National Geographic Society in 1985. On his second visit Ballard place a plaque from the **THS** on the hull of the ***Titanic***.



In addition to all of its historical pursuits the Society has also been and continues to be invloved the the U.S. Coast Guard's International Ice Patrol. With their cooperation a wreath has been placed annually at the ***Titanic's*** grave every April.

If you are interested in the **Titanic Historical Society** you can obtain more information by writing to:

Titanic Historical Society, Inc
P.O. Box 53
Indian Orchard, MA 01151–0053, USA

North Atlantic Tropical Cyclones, 1988

Nearly a decade of calm came to an end in the Caribbean Sea as two major storms—Gilbert and Joan— wreaked havoc in these waters.

James M. Gross
and Miles B. Lawrence

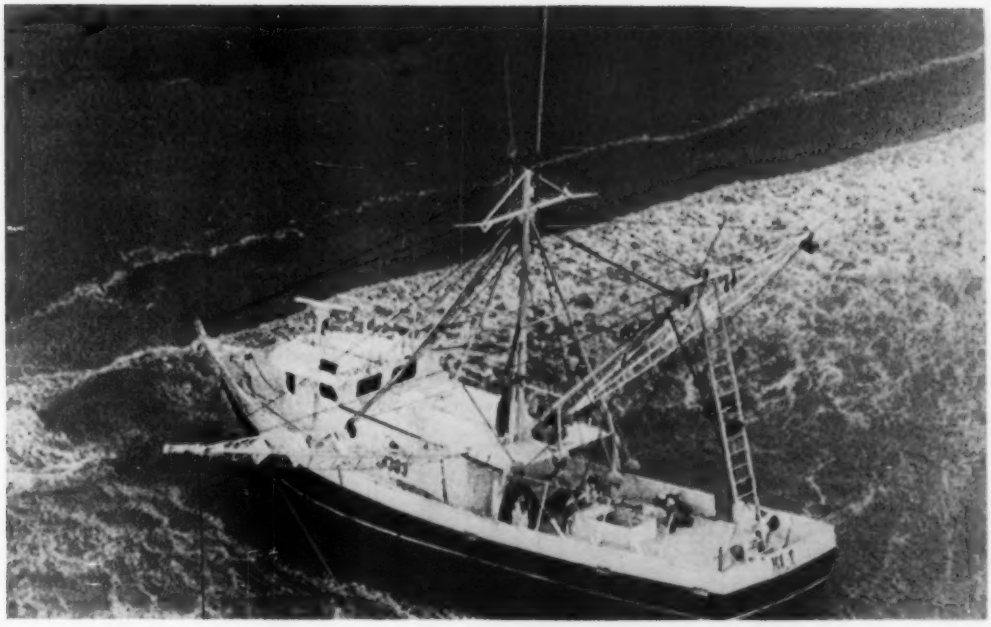
The hurricane season of 1988 will be remembered as the season of Hurricane Gilbert. Never had a pressure so low— 888 millibars (26.22 inches)— been measured in the Western Hemisphere. For years the standard was the Labor Day Hurricane of 1935, which ravaged the Florida Keys. Its pressure, measured near the north end of Long Key, was 892 millibars (26.34 inches).

However while Gilbert was a damaging, record–breaking storm, reaching category 5 on the Saffir/Simpson Scale, Helene and Joan reached category 4. Its been 27 years since three hurricanes have achieved that status in a single season. Gilbert wrecked havoc across the central and northwestern Caribbean and southwestern Gulf of Mexico, killing 318 people. Joan the other major Caribbean hurricane was responsible for 216 deaths, mainly along the southern and southwestern coast of the Caribbean. Joan's track was unusual since no other tropical cyclone has travelled on so southerly a course, affecting the northern coast of South America from the Windward Islands through Central America.

The 1988 hurricane season for the North Atlantic Ocean, Caribbean Sea and Gulf of Mexico was above average with seven tropical storms and five hurricanes. This compares to a long term seasonal average of four tropical storms and six hurricanes. Debby, Florence, Gilbert, and Joan were hurricanes that made landfall while Beryl, Chris, and Keith made landfall as tropical storms.

Dr. James M. Gross and Miles B. Lawrence are forecasters at the National Hurricane Center in Miami, FL.

A passenger bus plows through water in the Mexican town of Campeche in the wake of hurricane Gilbert on the 18th of September. This was one of several towns hard hit by the hurricane. These passengers were lucky compared to those on four buses in the Monterrey area the day before. The buses were overturned and crushed by the Rio Santa Catarina River's floodwaters and several hundred people were killed.



Shrimp boats are coming but no dancing tonight. This 72–foot shrimp boat from Venice, IA is beached on the Texas coast near Boca Chica on the 17th of September. The crew was air lifted to safety as Hurricane Gilbert approached.

This season's tropical cyclone tracks are in general quite smooth and outline the western boundary of the North Atlantic subtropical high. As determined by the number of ships reporting 50 knots or greater, shipping was, for the most part, able to avoid this season's intense tropical cyclones. The exception was Tropical Storm Keith. Because of its rapid acceleration just before and after it became extratropical, it moved quickly through the western North Atlantic shipping lanes.

Tropical Storm Alberto

Alberto originated from a low pressure trough that formed on the 4th of August off the South Carolina coast. It reached tropical depression status on the 5th. Moving northeastward in advance of an approaching frontal trough, it became a tropical storm on the 7th, while centered just south of Nantucket, MA. It crossed Nova Scotia without significant effect and became extratropical near Newfoundland on the 8th.

There were no reported surface winds of tropical storm force. Alberto's tropical storm status was based on satellite intensity estimates and pressure readings from a NOAA data buoy located southeast of Nantucket, which showed a 7-millibar fall, in 3 hours, to 1004 millibars as the storm went by.

Tropical Storm Beryl

Like Alberto, Beryl formed from a low pressure area that was not of tropical origin. The first signs of a low-level circulation occurred within a low pressure area that had meandered westward across the northeastern Gulf of Mexico and was near the Mississippi coast on the 4th of August. The system gradually organized into a depression on the 7th, having drifted over southeastern Louisiana. The center drifted back to the Gulf Coast and was upgraded to a tropical storm the following day. On the 9th the center turned 180° and headed back over southern Louisiana. The highest reported sustained wind over land was 40 knots at Gulfport, MS on the 8th. Beryl's highest sustained wind over the water was 46 knots reported on the 9th from the ***Puritan***. Beryl weakened later that day, and by the 10th it had become extratropical.

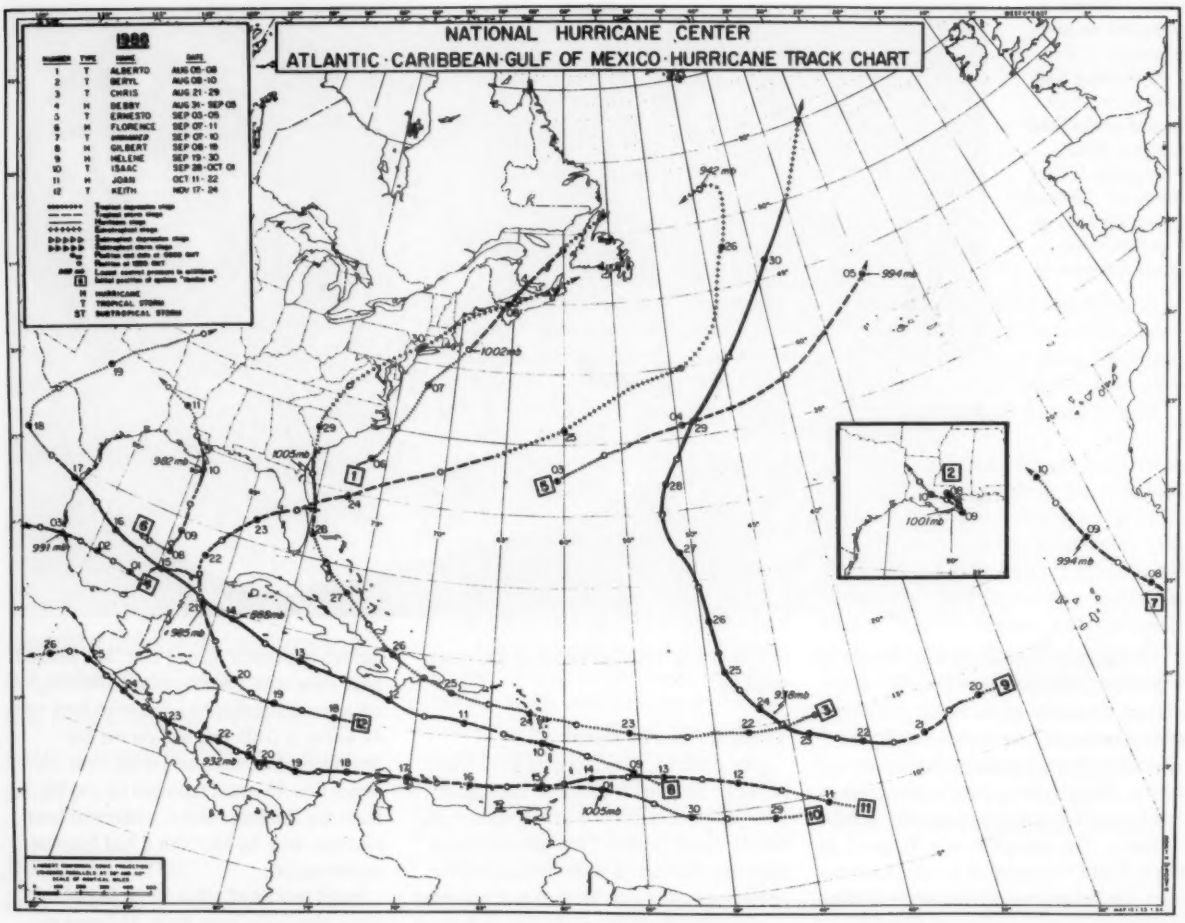
Beryl produced 10 to 12 inches of rain along the Gulf Coast from Alabama to Texas. Storm surge caused by onshore winds produced tides 3 to 5 feet above normal. The one death attributed to Beryl occurred when a 15-year-old boy drowned due to an overturned shrimp boat in Mobile Bay.

Saffir/Simpson Scale of Hurricane Intensity

Storm category	Storm surge (feet)	Mean wind speed (knots)
1 Weak	4—5	64—82
2. Moderate	6—8	83—95
3 Strong	9—12	96—112
4 Very Strong	13—18	113—135
5 Devastating	18—	136—

Tropical Storm Chris

A tropical wave was detected near the coast of Africa on the 15th of August. Its track across the subtropical Atlantic followed the southern periphery of the subtropical high. By the 21st, halfway between Africa and the Lesser Antilles, satellite imagery depicted a low-level circulation had formed. As a depression, the system moved over the islands of the northeast Caribbean. Four inches of rain fell on Puerto Rico on the 24th causing three deaths.



Early on the 28th, the depression was accelerating northward just off the southeast Florida coast when the ***Hoegh Carin*** reported 40-knot sustained winds 50 nautical miles northeast of the center. The system was upgraded to Tropical Storm Chris and the center crossed the South Carolina coast midday on the 28th, near Savannah. The highest reported sustained wind at the coast was 37 knots at the Savannah Light Tower.

Chris weakened to a depression over the Carolinas only 12 hours after becoming a storm and then merged with a cold front while turning extratropical. Rainfall totals ranged from 3 to 5 inches in a swath from South Carolina through Pennsylvania and into Vermont. One death resulted from a hurricane–spawned tornado in South Carolina.

Hurricane Debby

Debby originated from the same tropical wave that spawned Chris. On the 31st of August, this disturbance became a tropical depression over the southeast Bay of Campeche in the Gulf of Mexico. Drifting slowly westward, the depression strengthened to a tropical storm early on the 2d of September. Later that same day, based on aircraft reconnaissance, Debby became the 1988 season's first hurricane. It made landfall 6 hours later near Tuxpan, Mexico as a minimal hurricane with wind speeds of 65 knots.

Weakened by mountainous terrain, the remnants of Debby were tracked across Mexico by satellite into the eastern North Pacific Ocean. The weak circulation drifted northward for several days before finally dissipating in the Gulf of California on the 8th. No meteorological observations were received from the landfall area, but press reports indicated that inland flooding and mudslides caused 10 deaths in Mexico.

Tropical Storm Ernesto

An area of disturbed weather, associated with a tropical wave, turned northwestward while still far out in the central tropical Atlantic. The system was just east of Bermuda on the 2d of September when a surface low pressure area became associated with it. Recurving toward the northeast it became a tropical depression on the 3d and was upgraded to a tropical storm 6 hours later, based on satellite intensity estimates and reports from unidentified ships. Tropical Storm Ernesto accelerated and was absorbed by a large extratropical storm over the North Atlantic.

Hurricane Florence

Observations from unidentified ships, helped determine that on the 7th of September, a circulation formed in the south-central Gulf of Mexico. The system quickly strengthened to a tropical storm. On the 9th, it accelerated toward the northern Gulf Coast and became a hurricane just before making landfall over southeastern Louisiana. Florence quickly weakened as it moved over the New Orleans area and dissipated on the 11th in east Texas.

Florence was a hurricane for only 12 hours. The highest sustained wind near the surface was 70 knots reported from an oil rig (MP 73) near the Mississippi River Delta. Florence's lowest surface pressure, estimated from Air Force reconnaissance, was 982 millibars. Rainfall totals ranged up to 4 inches along the path of the storm. Storm surge water levels rose from 3 to 6 feet above normal along the southeast Louisiana and Mississippi coasts just east of where the center moved ashore. Several tornados and inland river flooding were reported from the western Florida Panhandle, far from the center of the hurricane. As a result of Florence, one fisherman died in Mobile Bay while trying to secure his boat. The damage total is estimated at $2.5 million, primarily in southeastern Louisiana.

Unnamed Tropical Storm

While Florence and Gilbert were forming farther west, an area of disturbed weather moved off the African coast. On the 7th of September, based on satellite imagery, the area was declared a depression while only 85 nautical miles off the African coast. An after-the-fact review of ship data indicated that the depression reached tropical storm strength that same day. The key ships used to determine this were the ***Baco-Liner 2, Antchar*** and the ***Stollberg***, which reported sustained wind speeds of 35 knots associated with this system. The storm moved north northwestward for the next two days and merged with a large low pressure trough. The entire track of the tropical storm remained east of 25°W.

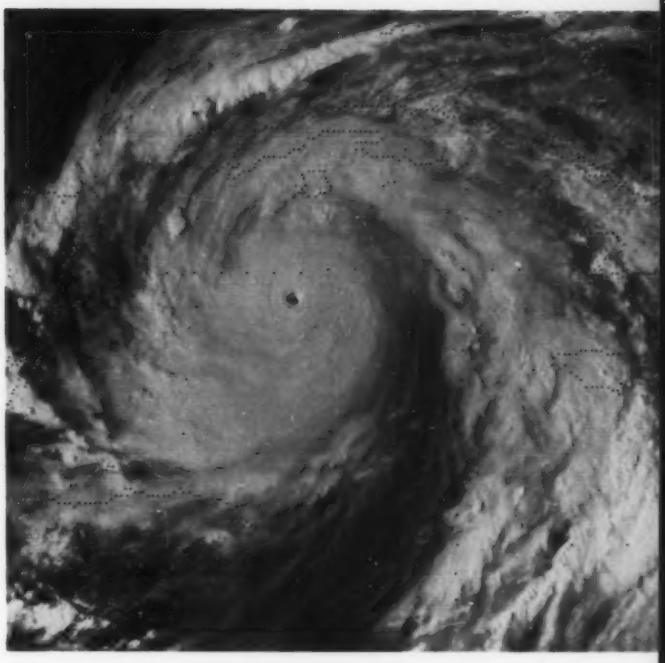
Hurricane Gilbert

The source of Gilbert was a tropical wave which left the African coast on the 3d of September. It developed a low-level circulation and became a tropical storm on the 9th. The next day it reached hurricane intensity while south of Puerto Rico, and on the 11th passed close to the southern coast of Hispaniola.

Gilbert was a category 3 on the Saffir/Simpson intensity scale when its well-defined eye passed from east to west across Jamaica on the afternoon of the 12th. A sustained wind of 101 knots was measured at the Kingston weather office along with a minimum pressure of 965 millibars. A ham radio operator also reported a sustained wind of 105 knots near Kingston. Most surprisingly, aircraft observations reported a minimum central pressure of 940 millibars when the eye crossed the east coast and the same value when the center moved off the west coast — hours later.

Following Gilbert's passage over Jamaica, a remarkably rapid intensification occurred as the storm passed just south of Grand Cayman on the 13th. The hurricane's central sea level pressure fell 72 millibars in 24 hours to reach a new record minimum pressure of 888 millibars (26.22 inches) for the Western Hemishpere. The NOAA reconnaissance aircraft, which made the pressure observation, also measured flight-level winds of 160 knots in the eyewall.

The next day at a slightly higher central pressure, Gilbert made landfall on the northeast Yucatan Peninsula, near Cozumel, Mexico. Sustained winds at landfall were estimated near 150 knots, making this a Saffir/Simpson category 5 landfall, the first since Camille in 1969. Gilbert weakened over the Yucatan Peninsula and moved over the southwest Gulf of Mexico during the next 2 days. Its final landfall occurred late on the 16th as a category 3 hurricane near the town of La Pesca on the coast of Mexico about 110 nautical miles south of the Texas border. After moving inland, Gilbert weakened as it turned north across Texas and into Oklahoma where it merged with a frontal low pressure system. This system continued to produce high winds as noted by the ***Roger M. Simons*** in southern Lake Michigan which reported 52 knots on the 20th.



One hour before the record— a visible satellite picture of Hurricane Gilbert taken at 2031 UTC on September 13, 1988. This was about one hour prior to the observation of the NOAA reconnaissance aircraft, which put the hurricane's central sea level pressure at 888 millibars. This now becomes the record low for the Western Hemisphere. In the western North Pacific the record low was set by Super Typhoon Tip on October 12, 1979 at 870 millibars. This is the world record for a tropical cyclone.

Storm surge flooding produced tides to 9 feet above normal on the northeast coast of Jamaica and 5 feet above normal at Grand Cayman. Extreme storm tides of as much as 15 feet were reported also along the northern and northwestern portions as the storm pushed off the Yucatan. The total death toll associated with Gilbert was estimated to be 318 deaths, including: Mexico 202, Jamaica 45, Haiti 30, Guatemala 12, Honduras 12, Dominican Republic 5, Venezuela 5, United States 3, Costa Rica 2 and Nicaragua 2. Besides being a very intense hurricane, Gilbert was large in areal extent. Deaths in countries far from the hurricane's center were caused by heavy rainfall and resultant flash flooding. Damage estimates are $2 billion (U.S.) each in Jamaica and in Mexico. The U.S. damage total is $50 million, primarily associated with tornadoes occurring near San Antonio, Texas. The total damage estimate for Gilbert is $5 billion.

Hurricane Helene

On September 15th, as Gilbert was entering the Gulf of Mexico, a tropical wave moved off the African coast. It organized into a depression on the 19th,

Gilbert's Effect on Sea Surface Temperature

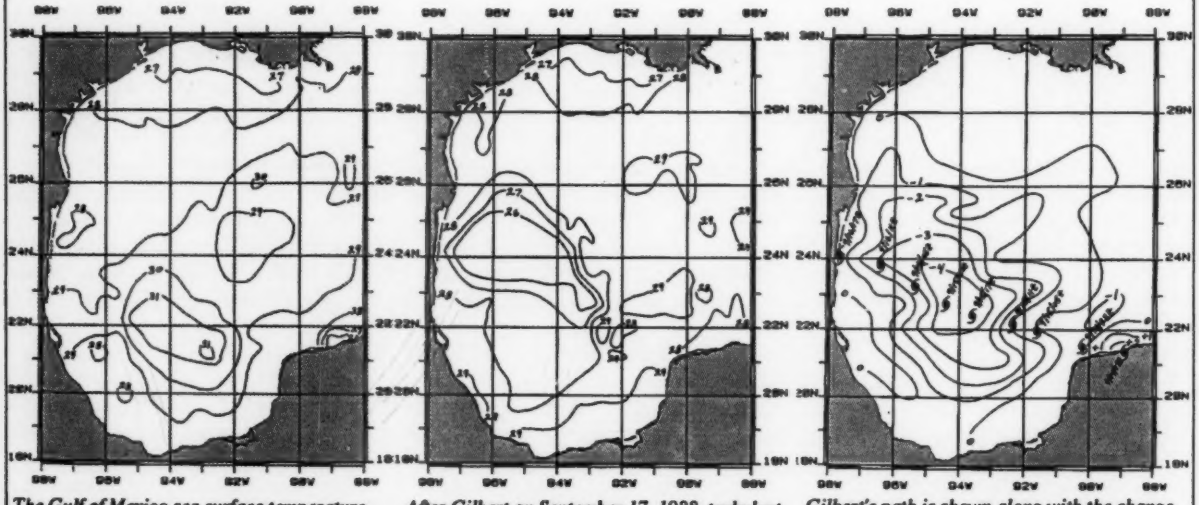
Gilbert was one of the strongest hurricanes in history. Its damge and death figures were well publicized. Some of the hurricane's aftermath was less conspicuous. One of the lesser-known effects of Gilbert's trek from the Yucatan Peninsula into northern Mexico was a dramatic cooling of Gulf of Mexico sea-surface temperatures (SSTs). The Gilbert-produced SST pattern persisted into the following week and was not a short-lived phenomenon. As late as October 15th, one month after Gilbert, SSTs had not recovered to their September 10th values.

Besides the obvious cooling in the Bay of Campeche and western Gulf, Gilbert produced another anomaly in the SST structure. Along the northern tip of the Yucatan Peninsula existed a region of cooler water caused by upwelling. As Gilbert moved from the Caribbean across the Yucatan into the Gulf of Mexico, this cool pattern was altered by turbulent mixing, causing the SSTs to actually warm by as much as 2°C (3°F).

A theory exists that Gilbert had a far-reaching effect on Hurricane Joan, a month later. Along the northern coast of South America is a region of cooler water, historically a graveyard for hurricane or tropical storm formation or intensification. The path of Gilbert took it to the north of this region, but close enough to possibly mix this water and alter SSTs upward, as was the case in northern Yucatan. Speculation is, Joan gained strength from the rearranged thermal structure, rather than weakened as would normally be the case, as she passed westward across this then-warmer water. Joan would eventually become one of the most powerful storms ever to strike the Central American isthmus.

A cursory examination of available SST data in this region was inconclusive. Perhaps further studies, utilizing more precise data, may validate or refute this theory.

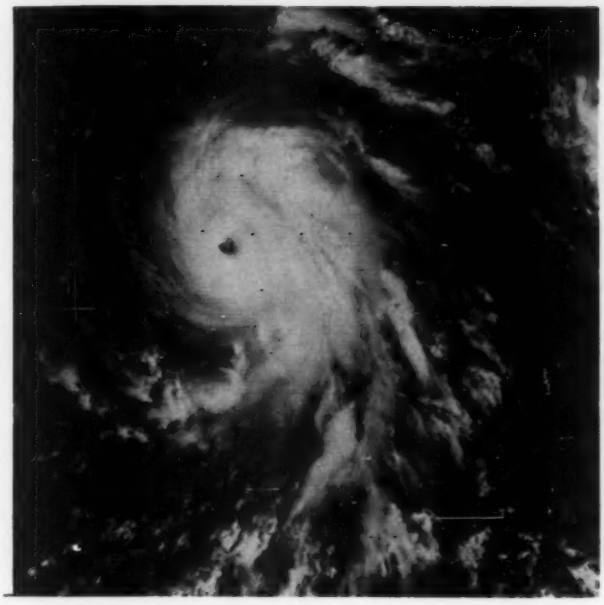
by Larry Peabody and Anthony Amos

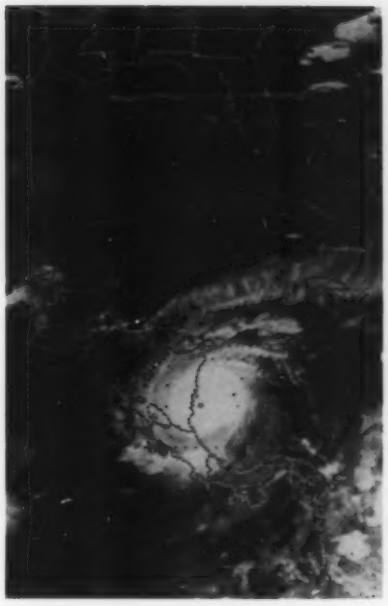


The Gulf of Mexico sea surface temperature pattern on September 10, 1988. Before Gilbert's arrival a warm core of 31°C (88°F) is located in the Bay of Campeche.

After Gilbert on September 17, 1988, turbulent mixing brings cool subsurface water to the surface (upwelling); also rain and cloud cover adds to the almost 5°C (9°F) drop.

Gilbert's path is shown along with the change in sea surface temperature between the 10th and 17th of September. It can be assumed that the mixing extended to 30 meters or more.





Hurricane Helene, left, poses for a photograph at 1301 UTC on September 23, 1988. This was near the time of maximum intensity, when winds reached 125 knots and pressure dipped to 938 mb. Hurricane Joan (right) is displayed in an infrared satellite picture at 0601 on the 22d of October. This was just before landfall near Bluefields, Nicaragua, as a category 4 hurricane. Joan later became Miriam in the eastern North Pacific.

increased to a tropical storm on the 20th and became a hurricane on the 21st over the mid tropical Atlantic. Helene began a northward turn on the 23d and for the next week moved northward. On the 28th Helene turned toward the northeast and accelerated. It became an extratropical system on the 30th, but remained far at sea.

Satellite pictures showed a well-defined eye for much of its lifetime. It is estimated that Helene's winds reached a maximum of 125 knots on the 23d, a category 4 on the Saffir/Simpson scale. Helene was estimated to be a hurricane for 9 days making it the longest-lived hurricane for this season.

Tropical Storm Isaac

The origin of Isaac was tracked back to a weak disturbance located near the African coast on the 23d of September. The westward moving disturbance became a depression on the 29th. It was upgraded to a tropical storm late on the 30th when an Air Force reconnaissance plane reported flight-level winds of 50 knots, while its center was about 200 nautical miles east southeast of Barbados. Shortly, thereafter, the storm weakened and dissipated.

Hurricane Joan

Joan developed into a tropical storm on the 11th of October in the mid tropical Atlantic. The storm moved through the Windward Islands on the 11th and then across the southern Caribbean. Its center affected the north coasts of Venezuela and Colombia, including the Netherlands Antilles.

Soon after the storm moved away from the La Guajira Peninsula of Colombia, strengthening began and Joan became a

1988 North Atlantic Tropical Cyclones

Name	Class[1]	Dates[2]	Maximum sustained wind (knots)	Lowest pressure (mb)	U.S. damages ($millions)	Deaths
Alberto	T	8/5—8	35	1002		
Beryl	T	8/8—10	45	1001	3.0	1
Chris	T	8/21—29	45	1005	0.5	4
Debby	H	8/31—9/5	65	991		10
Ernesto	T	9/3—5	55	994		
Florence	H	9/7—11	70	982	2.5	1
unamed	T	9/7—10	50	994		
Gilbert	H	9/8—19	160	888	50.0	318
Helene	H	9/19—30	125	938		
Isaac	T	9/28—10/1	40	1005		
Joan	H	10/10—23	115	932		216
Keith	T	11/17—24	60	985	3.0	

[1] T: tropical storm, wind speed 34—63 knots
H: hurricane, winds speed 64 knots or higher

[2] Dates begin at 0000 UTC and include tropical depression stage

hurricane. Joan made landfall on the coast of Nicaragua near Bluefields early on the 22d, as a Saffir/Simpson category 4 hurricane, with maximum sustained winds estimated at 125 knots and a central pressure of 932 millibars. Joan weakened to a tropical depression as it crossed Central America into the eastern Pacific Ocean. It later reintensified to become Tropical Storm Miriam in the eastern North Pacific.

Joan was responsible for an estimated 216 deaths across the southern Caribbean including: Nicaragua 148, Costa Rica 28, Colombia 25, Venezuela 11, and Panama 4. The total damage estimate was $2 billion with nearly half of that in Nicaragua.

Tropical Storm Keith

Keith's initial low-level circulation was detected over the central Caribbean late in the season on the 17th of November. It became a tropical storm on the 20th and moved on a northwesterly track that took its center over the northeast tip of the Yucatan Peninsula the next day. The storm recurved northeastward across central Florida on the 23d. Keith almost became a hurricane on the 21st when the ***Mariano Moctezuma***, located near Cozumel off the eastern Yucatan, reported gusts to 80 knots and 985 millibars while a ship in Puerto Morelos reported 60-knot winds with gusts to 80 knots.

The storm center moved inland near Sarasota, FL on the 23d. The highest sustained wind reported in Florida was 55 knots north of the center in the Tampa area. Sustained gale force winds were also reported south of the center through Fort Myers. No deaths were reported due to Keith but the damage estimate for Florida was $3 million. Keith moved off the Florida east coast and headed out to sea. Bermuda reported sustained winds of 40 knots on the 24th as the storm went by to the north. Keith became extratropical and its rapid acceleration during this stage did not allow adequate time for shipping to clear its path. As a result there were a large number of ships reporting 50-knot or greater winds for this storm.

Tropical Cyclone Winds
(ship encounters of 50 knots or more)

Tropical Cyclone	Vessel Name	Date Mo./Da	Time UTC	Ship Position Lat°N, Lon°W	Wind Dir/Speed (kn)	Pressure (Mb)
Unamed	ZGKH	9/8	1200	18.3, 20.2	020/50	1008.3
Gilbert	Monsun	9/10	1200	15.8, 62.7	140/50	1004.0
	Ronneburg	9/13	0000	22.0, 77.3	090/52	1005.0
	Overseas Chicago	9/14	1800	20.3, 84.1	180/50	1002.0
	Sealift Atlantic	9/15	1800	19.9, 94.9	290/60	999.8
	KR4370	9/20	0000	42.8, 87.0	270/52	
Helene	Zhalgiris	9/30	1200	47.7, 31.9	200/50	992.6
	Edinburgh Talla	9/30	1200	49.6, 25.2	180/52	1002.7
Keith	Mariano Moctezuma	11/21	0300	W of Cozumel		985.0
	SHIP	11/21	0700	20.8, 86.8	/60	
	ABKC	11/22	1800	24.9, 84.5	190/54	994.6
	Rhine Forest	11/24	0000	26.0, 78.2	120/54	1005.0
	MSC Chiara	11/25	1200	34.8, 48.8	180/53	988.0
	Fairload	11/25	1200	36.5, 49.5	190/55	983.0
	Zim Savannah	11/25	1200	37.7, 50.2	190/55	972.0
	Sonora	11/25	1800	40.3, 41.9	180/60	978.5
	Lexa Maersk	11/25	1800	45.6, 42.7	140/52	964.0
	Demyansk	11/26	0000	42.8, 49.9	340/50	957.5
	Lok Pragati	11/26	0000	44.4, 41.5	180/52	958.7
	Ziemia Olsztynska	11/26	0000	47.1, 43.0	110/78	951.0
	Margit Gorthon	11/26	0000	49.2, 40.5	090/60	968.0
	Sealand Integrity	11/26	0600	46.8, 39.8	220/60	973.0
	Margit Gorthon	11/26	0600	49.3, 42.7	180/60	945.0
	KNDB	11/26	0600	49.7, 41.0	200/55	947.6
	JCLL	11/26	1200	49.0, 40.0	220/57	974.2
	Margit Gorthon	11/26	1200	49.3, 43.2	230/63	964.0
	KNDB	11/26	1200	49.4, 40.5	200/65	968.0
	Margit Gorthon	11/26	1800	49.3, 43.1	200/55	972.0

When it's done holding your ship's garbage, it could hold death for some marine animals.

This plastic trash bag may not look like a jellyfish to you. But to a hungry sea turtle, it might. And when the turtle swallows an empty bag, the mistake becomes fatal.

The problem is more than bags. Plastic six-pack holders sometimes become lodged around the necks and bills of pelicans and other seabirds, ultimately strangling or starving them. Other plastic refuse, either through ingestion or entanglement, causes the deaths of thousands of seals, whales, dolphins and other marine mammals every year.

Plastic debris also causes costly and potentially hazardous delays to shipping when it fouls propellers or clogs intake ports.

It's a critical issue, destined to attract public and government scrutiny if we fail to take action to solve it.

So please, stow your trash, and alert your shipping terminals that you will need proper disposal on land. A sea turtle may not know any better. But now, you do!

To learn how you can help, write: Center for Environmental Education, 1725 DeSales Street, N.W., Suite 500, Washington, D.C. 20036.

A public service message from:
The Center for Environmental Education
The National Oceanic and Atmospheric Administration
The Society of the Plastics Industry

The Chicago Seiches

Seiches in southern Lake Michigan are rare, although not by Cub pennant standards. Five major seiches have posed a threat to lives and property along the Chicago lakefront in the past 35 years.

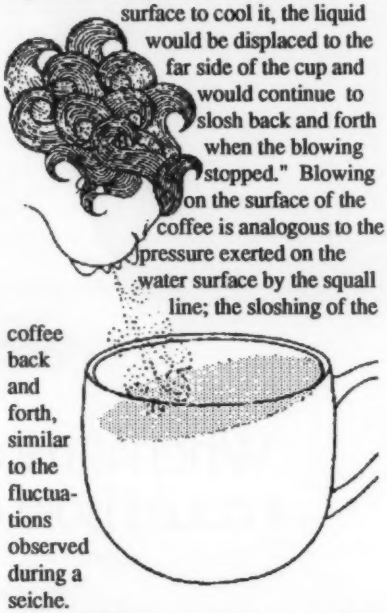
Jane A. Hollingsworth

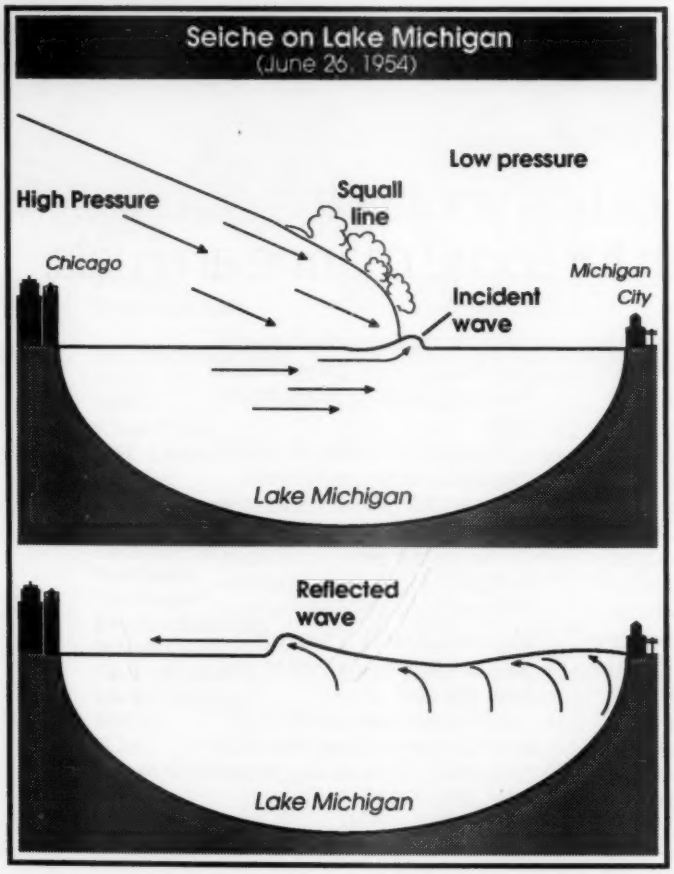
On June 26, 1954, a 10–foot wave rose suddenly from a placid Lake Michigan. Before they could react, eight fishermen were swept to their deaths off of a breakwater, at the entrance to Montrose Harbor. The *killer wave* had actually bounced off of the east shore of Lake Michigan and back to the Chicago lakefront. This phenomenon is a known as a **seiche**, pronounced *saysh*.

On the Great Lakes, especially lower Lake Michigan, significant seiches are caused by fast moving lines of thunderstorms, or squall lines. The strong downdraft winds and pressure jump created by the line form a long, shallow wave which causes a surge of water on the east shore of the Lake, at about the same time as the thunderstorms pass there. This wave is then reflected back to the west shore. The resulting fluctuation at that point is termed a seiche.

A seiche is a standing wave oscillation of an enclosed water body that continues, pendulum fashion, after the cessation of the originating force, either seismic or atmospheric.

As meteorologist Lawrence A. Hughes explains: "If... you blew on the coffee surface to cool it, the liquid would be displaced to the far side of the cup and would continue to slosh back and forth when the blowing stopped." Blowing on the surface of the coffee is analogous to the pressure exerted on the water surface by the squall line; the sloshing of the coffee back and forth, similar to the fluctuations observed during a seiche.





The initial wave created by a squall line is very long, maybe up to 20 miles, but only a few inches high in the deep water. The deeper the water, the faster the wave moves. The wave in Lake Michigan, because of its depth, could move at 50 to 100 knots.

The speed of the thunderstorms is the key factor, because a significant seiche won't occur unless the squall line moves at the same speed as the water wave. The critical direction and speed of movement for a seiche-producing squall line is from the northwest (about 340 degrees) at around 55 knots.

Jane Hollingsworth is a forecaster at the Weather Service Forecast Office, Chicago, IL.

The actual buildup in height of this small wave occurs when the wave moves into shallow depths. Friction slows the forward edge while the back edge continues at a rapid rate, causing a piling up of the water.

Vessels have been known to hit bottom as the water level drops.

Once the squall line passes the city of Chicago, it generally takes about 1 1/2 to 2 1/2 hours before the seiche hits the Chicago area lakeshore. The seiche then has two parts.

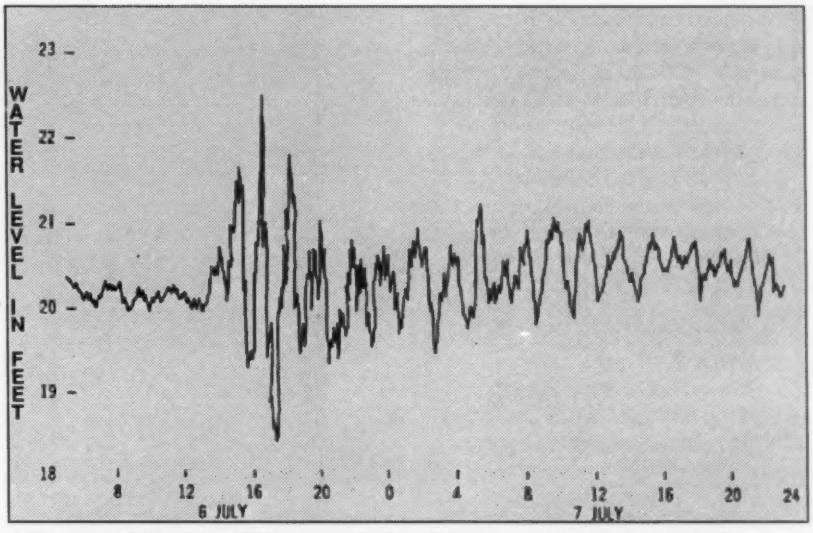
First, there is a rise of water at the lakeshore. The rise can be gradual and rather undramatic, or it can be sudden and powerful, as in the June 1954 case. With this first stage, the risk is to persons out on long piers that may not have time to reach shore, or perhaps to children playing in the previously shallow and calm water.

Second, there is the withdrawal of the water, which is sometimes more spectacular than the rise. The risk at this point is to boats, generally 200 to 400 yards from shore, where the fluctuations can be disastrous. Vessels have been known to hit the bottom as the water level drops. Docked boats can also be affected as the water level changes and stretches lines beyond their limits, actually tearing the lines or damaging vessels.

Compounding the problem of this *silent killer* is the time at which it strikes.

The maximum rise of water is usually about 4 feet on the east shore of Lake Michigan, and up to 8 feet or more on the west shore. Several lesser surges will occur at about 30–minute intervals after the initial peak surge. This sloshing of the water back and forth in the Lake basin could continue for up to 24 hours.

Since squall lines do not frequent the Great Lakes region anyway, a line of thunderstorms moving at *optimum* speed for a major seiche is somewhat of a rare event. In fact, there have only been five major seiches on the Chicago lakefront in the past 35 years. They occurred on June 24 and July 6, 1954, August 3, 1960, June 7, 1980, and June 12, 1983. Water level changes were generally in the 3– to 6–foot range, except the June 1954 episode.



The second 1954 seiche at Chicago was the first of these rare events to be forecast by the National Weather Service. The magnitude is not as great as that close to shore, as the gage at the Wilson Av. Crib is 2 miles offshore.

Compounding the problem of this *silent killer* is the time at which it strikes. The very nature of the seiche is such that it develops after an episode of stormy weather. However, in the wake of such a squall line, the weather is typically fair, with light winds. Lake enthusiasts have already ridden out the stormy weather and are ready to hit the water again as sunny skies and gentler winds prevail.

There were three noteworthy situations during the summer of 1988 in which seiches were reported along the Chicago lakeshore.

The forecasting problem regarding the seiche remains not so much in the timing of the event, but in the magnitude of the fluctuations. This could be due to the length of the squall line, which now can be determined from satellite and radar observations, but which is not as yet incorporated into the forecast scheme.

Other factors in determining the magnitude of a seiche involve the bathymetry of the lake basin and shape of the *reflecting* shore— in this case the east shore of Lake Michigan. These criteria seem to *favor* seiches in the Chicago area.

There were three noteworthy situations during the summer of 1988 in which seiches were reported along the Chicago lakeshore. The occurrences were on June 22, July 15, and August 15. Water level drops associated with these situations were generally in the 1 to 4 foot range, so the seiches were relatively minor.

Case No. 1

The first Chicago area seiche, in the summer of 1988, occurred on June 22 and was reported around 1:45 pm CDT. It is not certain from the calls received at the Chicago National Weather Service Forecast Office if this was the exact time of the level fluctuation.

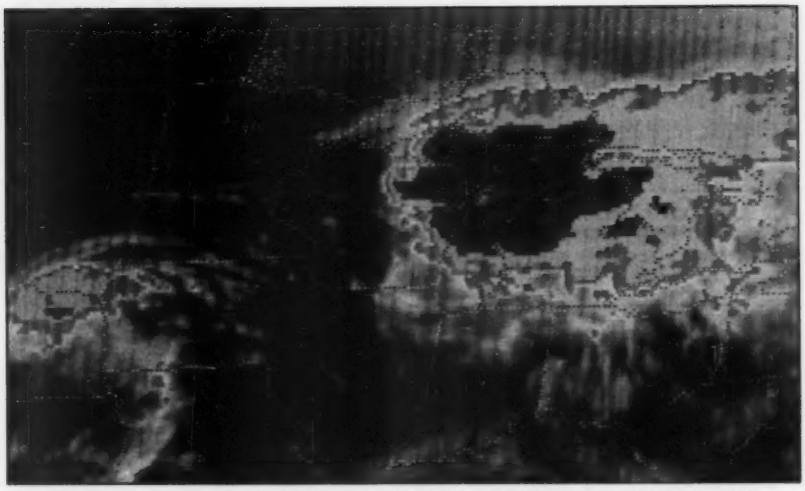
Satellite pictures from June 22 indicated an east northeast-west southwest line of thunderstorms extending from central Michigan across northwest Illinois into the southeast corner of Nebraska. At 10:00 am CDT the strongest storms stretched across

south–central Lake Michigan to central Lake Huron. The line moved southeastward to the southern tip of Lake Michigan and northwestern Indiana by 12:30 pm, which was about 1 1/2 hours before the reported seiche at Chicago.

Leonne Harbor, on the far north side of the city, reported a 1– foot drop. Rainbow harbor, about 18 miles farther south along the lakeshore, had a 1 1/2–foot drop. South of there, at Calumet Harbor, the drop was 3 feet.

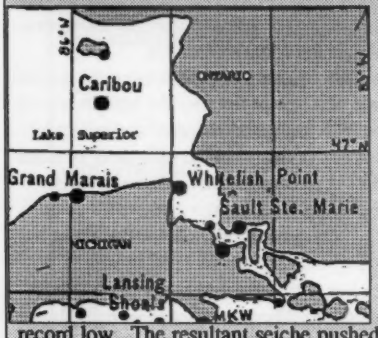
Case No. 2

The second seiche of the summer occurred on July 15th. At about 9:00 pm CDT the satellite indicated a large thunderstorm complex from the eastern half of Wisconsin into Upper Michigan, Lake Superior, and Lake Michigan. An hour later the storms had sagged southeastward,



A large thunderstorm complex is visible over Lake Michigan at 1301 CDT on the 15th of July, 1988. This complex was so large that it affected water levels on Lake Superior earlier in the day. The Soo Locks at Sault Ste. Marie, MI reported a 5–foot rise in water level in 1 1/2 hours.

Record Low Water Level at the Soo

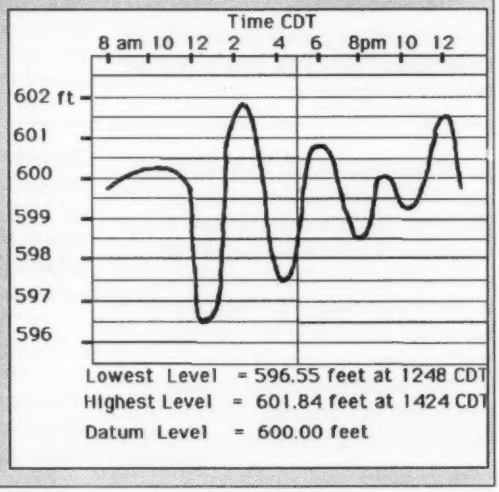


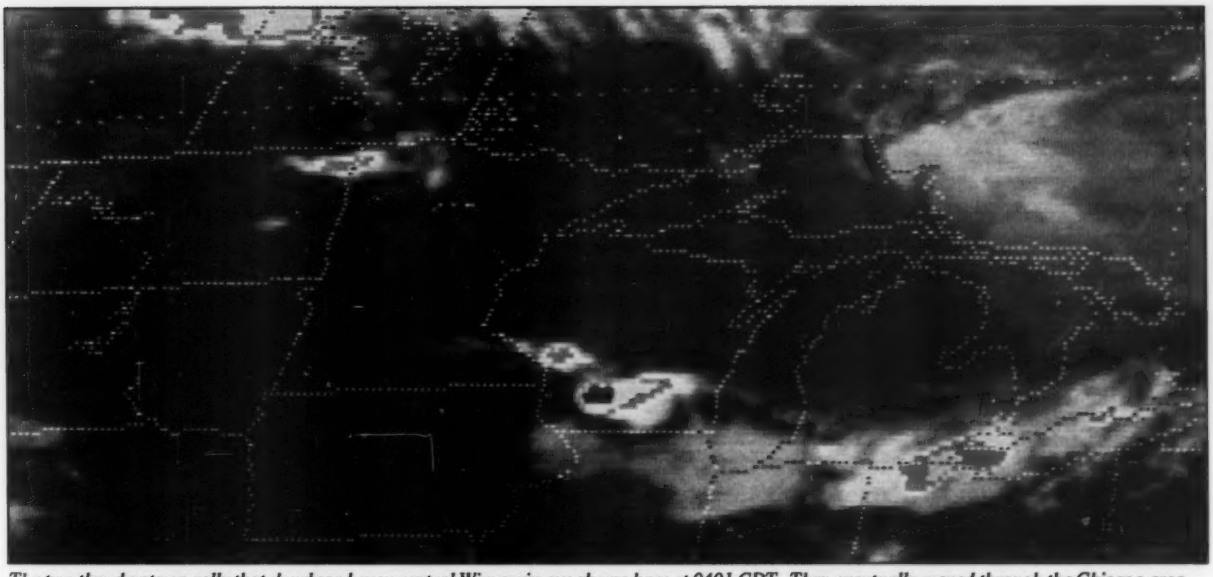
The thunderstorm complex on July 15, 1988 affected water levels in Lake Superior. At 1248 CDT, the water level in the Soo Locks at Sault Ste. Marie, MI reached the lowest recorded level since the National Ocean Service began keeping records there in 1934. The level, 596.55 feet above sea level, represented a level 3.45 feet below International Great Lakes Datum (IGLD).

Thunderstorm winds at Grand Marais, MI peaked at about 45 to 50 knots at 1100, 1300 and 1500 CDT. Winds at the Sault Ste. Marie National Weather Service Office were from the south southeast at around 10 knots until 1130 CDT. Sustained wind speeds then rose to 30 knots at 1201 CDT, with gusts to 45 knots, before dropping back to 10 knots by 1245 CDT. The pressure at Sault Ste. Marie plummeted from a high of 992.2 mb at about 1015 CDT to 979.3 mb at 1145 CDT— a drop of about 13 mb in 90 minutes! Apparently the combined force of the thunderstorm winds blowing away from the Soo, and the rapid pressure change, was sufficient to drop the water level to a record low. The resultant seiche pushed the water level at the Soo Locks to a level of 601.48 feet above sea level at 1424 CDT, a rise of 5.29 feet in 96 minutes, before dropping to a secondary low of 597.5 feet above mean sea level at about 1600 CDT. The water level at the Soo varied erratically within these limits for 48 hours after the initial drop in water level. It is believed that the strong winds over Whitefish Bay and extreme Eastern Lake Superior pushed water away from the mouth of the St. Mary's River. The river, being narrower than Whitefish Bay, showed a disproportionately large decrease in water level because of its small surface area compared to Whitefish Bay.

While the events described here are beyond the range of present forecast expertise, mariners and shoreside interests should be alert to the fact that fluctuations of water levels, particularly in restricted waterways, can occur rapidly due to the effects of persistent strong winds along with extreme changes in atmospheric pressure.

—Cleveland National Weather Service Forecast Office





The two thunderstorm cells that developed over central Wisconsin are shown here at 0401 CDT. They eventually moved through the Chicago area at 0600 CDT. The direction of movement was from 300° at 40 to 50 knots. The direction and speed approached prime conditions for producing a seiche.

and by 10:30 am the strongest storms had moved to just south of Muskegon Michigan, on the east shore of the Lake. Movement was generally from 300° at about 30 to 40 knots. This resulted in a lowering of about 3 to 3 1/2 feet of water with a slow gradual rise of 2 feet at both Calumet Beach and North Shore. The observations came from the Chicago Park District. Coast Guard personnel at Wilmette and Calumet reported 3– to 4–foot fluctuations, with levels lowering 2 to 3 feet in less than 10 minutes at Calumet!

Case No. 3

The final seiche of any consequence, during the summer of 1988, occurred on August 15th. At 3:00 am satellite imagery displayed two thunderstorm cells developing in south–central Wisconsin extending to the northwest toward La Crosse. The cells were developing in a train echo pattern, with the entire line shifting eastward. Thunderstorms moved across the Chicago area at 6:00 am and at 9:00 am the cells had moved rapidly southeastward to northeastern Indiana. Movement of the storms was from 300° at 45 to 50 knots, with tops as high as 48,000 feet. (Note that the direction/speed values approach *prime* conditions.) In terms of critical values, this was the most favorable scenario of the three. However, satellite pictures revealed a much smaller thunderstorm system than those that produced the previous two seiches. Reports of 3–foot water level changes were reported from no less than six different harbors along the Chicago lakeshore, via the Coast Guard and Chicago Park District.

Seiches probably occur more frequently than once suspected.

While none of the three 1988 seiches had the impact of the 1954 seiche, they caused problems and taught some lessons.

Seiches probably occur more frequently than was once suspected. Satellite and radar have become important tools, particularly with respect to the development of a seiche. The magnitude of the water fluctuation remains difficult to delineate, due to the influence of factors like *reflectivity* of the east shore of lower Lake Michigan and slope of the lake bottom as the reflected wave moves toward the west shore. Work is continuing on these problems.

The forecaster and the mariner need to be especially alert, however, to those situations when *critical* values are reached; namely when a storm is moving southeastward at 50 to 60 knots across lower Lake Michigan.

It appears that thunderstorms moving east or southeast across Lake Michigan at the *lesser* speeds of 25 to 40 knots will cause seiches of the order of 1 to 4 feet. The forecaster and mariner need to be especially alert, however, to those situations when *critical* values are reached; namely when a storm is moving southeastward at 50 to 60 knots across lower Lake Michigan.

The episodes that were studied during the 1988 summer season fit quite well with the modeling done by Platzman in the early 1960's. Further case studies need to be supplemented with continued reporting of observed water level fluctuations with an effort at pinpointing time of occurrence as well as magnitude. The reports received from the Coast Guard and the Chicago Parks District by the National Weather Service have been invaluable.

The Platzman Technique

A technique developed by George W. Platzman, of the University of Chicago, was used to quantify the amplitude of the seiches, using surface observations as well as radar and satellite information. Observations were collected from Madison and Milwaukee, WI as well as from Rockford and Chicago, IL.

Case No. 1

In the June 22d seiche the average pressure jump at the collecting stations, when the thunderstorm line passed, was .04 inches of mercury. The average direction and speed of the squall line was 320° at 20 to 25 knots (well below the critical speed of 50 to 60 knots). From this information, using Platzman's graph for Montrose Harbor a value of 3 was derived for Platzman's formula:

7.5 x .04 x 3 = .9 feet

7.5 — empirical factor relating actual onshore surge heights to the computed offshore value of the Platzman graphs; also incorporates wind stress effects.
.04 — average pressure jump.
3— number obtained from Platzman graph using thunderstorm direction and speed.
The direction of propagation and relatively slow speed of the line could tend to favor a seiche of greater magnitude toward the southern end of the basin as noted by the 3–foot drop at Calumet.

Case No. 2

In the second seiche, on July 15th, a factor of 4.5 was obtained from the graphs while an average pressure rise of .06 inches was noted. The resulting water level rise was calculated as follows:

7.5 x .06 x 4.5 = 2 feet

This was less than the observed value, although it gave the forecaster a *ballpark* figure to work with. The seiche should have occurred about 2 1/2 to 3 hours after Milwaukee had thunder — about 11:00 am. Since the thunderstorm was moving at only 30 to 35 knots, it would have been slower than indicated on Platzman's table. The water level disturbances were reported from about noon to 12:30 pm.

Case No. 3

In the seiche of August 15th the formula indicates:

7.5 x .08 x 7 = 4.2 feet

The timing of the seiche would have been about 1 1/2 to 2 1/2 hours after the thunderstorms hit Midway. This would be between 8:00 and 9:00 am. Platzman's graphs predicted a time of 8:45 am and the seiche was reported around 8:30 to 9:00 am. The formulas in this case worked out well with respect to both the magnitude and timing of the seiche.

More Detail

If you are interested in seeing exactly how the Platzman Technique works a technical description can be found in the **Monthly Weather Review**. The article entitled: *The Prediction of Surges in the Southern Basin of Lake Michigan*, appeared in the May 1965 issue (Volume 93, Number 5). If you don't have access to the publication or your library is unable to obtain a copy, write to the **Mariners Weather Log** and we will mail you a Xerox copy of the article.

This discarded net is done fishing. But it's not done killing.

When worn fishing nets or other plastic gear is dumped or lost in the water, something else happens: animals die.

Seabirds get caught in nets when diving for food, and drown. Other marine animals become entangled in them and slowly strangle.

Discarded nets and traps even compete with you, by needlessly catching and killing millions of pounds of potentially valuable fish and shellfish.

In addition, plastic wastes can foul propellers and block cooling intakes, causing costly vessel disablement.

Over 100,000 tons of plastic fishing gear are dumped into our oceans every year. This critical issue is destined to attract increasing public and government scrutiny if we fail to take action to solve it.

So please, alert your dock operators that you'll need trash facilities, because you're saving your plastic trash and worn out gear for proper disposal on land. That's not all you'll be saving.

To learn how you can help, write: Center for Environmental Education, 1725 DeSales Street, N.W., Suite 500, Washington, D.C. 20036.

A public service message from:
The Center for Environmental Education
The National Oceanic and Atmospheric Administration
The Society of the Plastics Industry

Kilauea Point Lighthouse

Elinor DeWire
Mystic Seaport Museum
Mystic, CT 06355

The westernmost of the main islands in the Hawaiian Archipelago is a lush, fecund isle surrounded by a deep tongue of ocean. Kauai, like a glittering green sequin on watery blue silk, faces the brunt of the trade winds. It's the first welcome piece of terra firma of any size for vessels heading in from the Orient.

A thousand years ago, Hawaiians kept the Fires of Lono, their sky god, burning on the shores of Kauai to guide fishermen home. They bundled kukui nuts, rich in oil, hung them from hemp lines, and lit them afire. Today, those lights still burn on Kauai, but by electricity rather than kukui oil. About a half-dozen beacons still mark its shores.

The most famous of these— Kilauea Point Lighthouse— is now just a daymark, but in its day it was one of the Pacific's most powerful and needed navigational aids. Situated on the remains of a large, weather–worn volcanic crater, the lighthouse faces the empty expanse of sea to the north of Hawaii. Sea stacks, arches, and caves keep it company— evidence of the power of the waves here.

The Hawaiians say the fire goddess Pele once lived in the caldera beyond the lighthouse. When she was angry, she threw her fiery hair across the land and spit orange plumes of lava. Pele left Kauai a few thousand years ago and moved to Oahu, then to Molokai and Maui, and finally to the Big Island where she currently resides. Her legacy to Kilauea Point is its name, which means *rising smoke cloud*, along with the spectacular black cliffs of volcanic rock rising from the caldera. Her orange lava soup was long ago replaced by seawater.

In 1863 an ambitious Yankee whaler named Charles Titcomb bought a large parcel of land on Kauai's north shore and planted some sugar cane. By 1904, when the U.S. annexed Hawaii as a territory and began improving access to its harbors with better navigational aids, Titcomb's cane farm had grown into an empire. The government, looking for a good spot to build a lighthouse that would answer the needs of shipping arriving from the west came upon the dramatic, lofty seascape at Kilauea Point. It was the perfect place for a lighthouse.

Due to the porous volcanic rock on the point, a deep concrete pad had to be poured.

A total of 36 acres was purchased from Titcomb's heirs, including a 5–acre islet just offshore called Mokuaeae. It's name means *fragment frothing in the rising tide* and is exemplary of the Hawaiians' resourcefulness in giving names to the many rocks and islets of their ocean home. The purchase price for point and islet was a mere $1.00, paid to Kilauea Sugar Plantation.

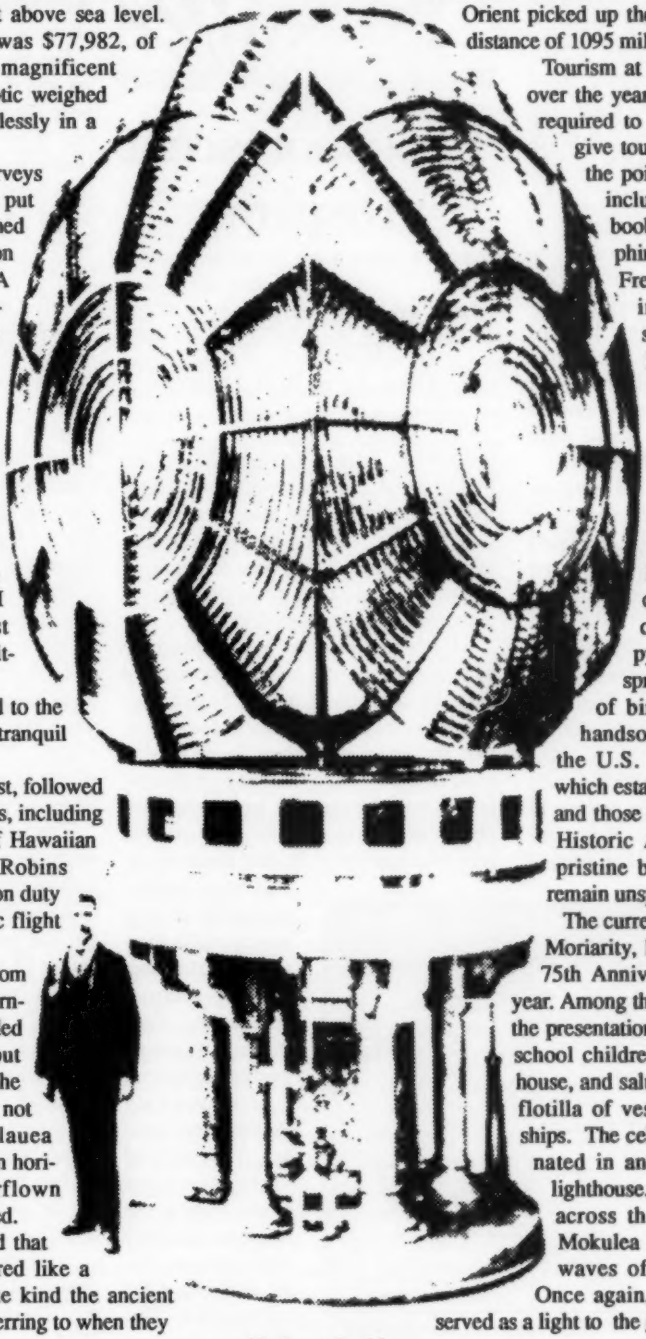
Construction of the lighthouse began July 8, 1912 by the 26–man crews of the tender ***Kukui***, a lighthouse service vessel named for those marvelous little oily nuts that had served as beacons centuries before. While the tender crew prepared the site with a derrick and landing 110–feet above sea, metal parts for the tower were fabricated by an Ohio firm, and the lens and clockworks were assembled in France by a reputable optical company. It was ironic that one of the sea captains who

U.S. Coast Guard

Kilauea Lighthouse sits in the Kilauea National Wildlife Refuge, Kaui, Hawaii. A small museum operates in the building next to the tower.

had recommended a lighthouse be built at Kilauea Point also had the pleasure of transporting its metal work to Hawaii aboard his vessel.

Due to the porous volcanic rock on the point, a deep concrete pad had to be poured. The finished tower rose 52–feet tall and cast a beam 216 feet above sea level. Total cost for the structure was $77,982, of which $12,000 went for its magnificent clamshell lens (right). The optic weighed over 4 tons, yet rotated effortlessly in a trough of mercury.



National Archives

Five years after the initial surveys of the site, the lighthouse was put into operation. Its beacon flashed on amidst great celebration on the night of May 1, 1913. A luau was held, and local residents engaged in a **shark shoot**, a popular amusement of the day. The 19th Lighthouse District Inspector, A.W. Arledge, recalled that special moment when the light first came on: "There is a cliff about 400 feet high about 300 yards southeasterly of the tower across which the beam of light rapidly swept. I believe that this is the most beautiful light station I have witnessed."

Three keepers were assigned to the station, and life for them was tranquil and pleasant.

Harry W. Flint took charge first, followed by a number of native islanders, including Samuel Amalu, "The Dean of Hawaiian Lightkeepers." Later, Fred Robins took over the station and was on duty the night the first trans–Pacific flight took place.

Air Force pilots took off from Oakland, California on the morning of June 28, 1927 and headed for Hawaii. Course errors put them 90 miles northwest of the islands, however, and had they not sighted the beam of Kilauea Lighthouse low on the southern horizon, they might have overflown Hawaii, run out of fuel, and died.

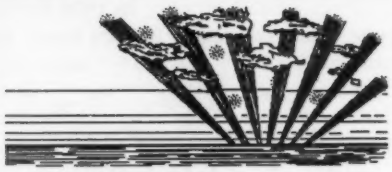
One of the pilots later noted that the lighthouse beacon appeared like a bright star on the horizon, the kind the ancient seafaring Polynesians were referring to when they chanted these words to god Lono: **"E hoike mai oe i kuu hoku!"** (Give me my star!)

In 1930 Robins also saw the addition of a radiobeacon at Kilauea Point. Its signals were to serve a radius of ocean of about 300 miles, but in 1938 a ship headed in from the Orient picked up the bearings from an incredible distance of 1095 miles!

Tourism at the point gradually increased over the years, and keepers were not only required to tend the beacon, but to also give tours of the station and interpret the point's abundant natural history, including albatrosses, frigatebirds, boobies, sea turtles, whales, dolphins, and lovely flowering ilima. Fred Robins was also known to impress visitors by bravely swimming out to the islet of Mokuaeae when sharks were feeding in the waters.

Kilauea was the last lighthouse in Hawaii to be automated and unmanned. In 1976 its doors were locked and the keepers removed. Shortly after their departure the light in the tower was discontinued and a substitute beacon was placed on a 15–foot pylon closer to the water. The sprawling complex with its acres of birdlife, keepers' homes, and handsome lighthouse was given to the U.S. Fish and Wildlife Service, which established a refuge. Their efforts, and those of the Kilauea Point National Historic Association, assure that the pristine beauty of Kilauea Point will remain unspoiled.

The current manager of the refuge, Dan Moriarity, had great fun celebrating the 75th Anniversary of the lighthouse last year. Among the events on May 1, 1988 were the presentation of a giant lei, made by local school children and draped over the lighthouse, and salutes by vintage biplanes and a flotilla of vessels, from canoes to cruise ships. The celebration finale at dusk culminated in an honorary relighting of the lighthouse. Its rich, golden beam swept across the volcanic cliffs of nearby Mokulea Point, then washed over the waves of the dark northern Pacific. Once again, if only for a few hours, it served as a light to the god Lono.



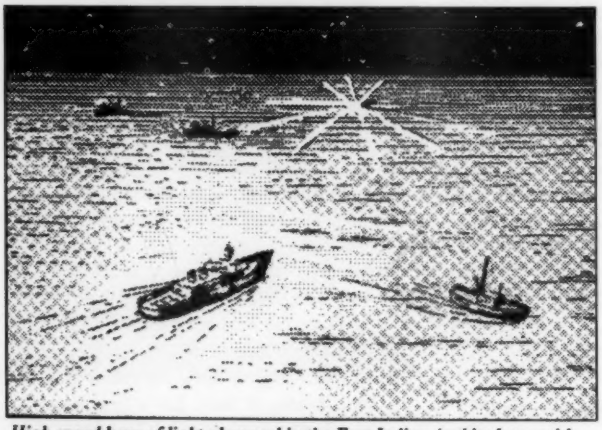
Phosphorescent Displays

William R. Corliss
P.O. Box 107
Glen Arm, MD 21057

Ships that ply the Indian Ocean, particularly the waters leading to the oil–sodden lands around the Persian Gulf, frequently encounter dazzling phosphorescent seas. As Kipling described it, the ship's wake is **"a welt of light that holds the hot sky tame."** Huge globes of light rise from the depths and burst on the surface. Wave tops sparkle, porpoise resemble luminous torpedoes, and broad geometrically precise corridors of light stretch from horizon to horizon. Buckets lowered into these glowing seas prove that marine organisms seem to cause most of the phosphorescent displays. For example on the 17th of February 1988 in the South Pacific the ***Mairangi Bay*** discovered groups of bright–green luminescent sea creatures along the side of the ship. These were found to be squid (**Marine Observer**).

Phosphorescent ship wakes are mundane and unimpressive compared to the vast rotating wheels of light and the other fantastic luminescent displays encountered from the Persian Gulf, across the Indian Ocean, and into the South China Sea. Ridiculed as wild sailors' tales for centuries, modern ships have reported scores of bona fide geometrical displays. Mariners tell of great spoke–like bands of light seemingly spinning about some distant hub. Occasionally several wheels will overlap, while simultaneously turning in clockwise or counterclockwise senses, creating a vast tableau of moving spokes miles wide. Expanding rings of light and bright whirling crescents (the latter radar–stimulated) may also decorate the ocean surface. Crews that see these fantastic apparitions do not soon forget them. Scientists, alas, have generally ignored these awe–inspiring apparitions.

One's first reaction is to explain the wheels of light and related geometrical displays in terms of marine bioluminescence stimulated by natural force that, like the wake of a ship, leave behind glowing evidence of their passage. Sound waves emanating from submarine disturbances have been the most popular type of disturbance in this explanation. But what combination of seismic waves could stimulate overlapping, counter–rotating wheels or hundreds of spinning phosphorescent crescents? Furthermore, there are several well–attested cases where the luminous displays were seen in the air well above the sea's surface. This fact plus the persistence of the phenomena (about half an hour) and the complex nature of the displays suggest that we look for other stimuli and nonbiological sources of light.



High speed bars of light observed in the East Indian Archipelago, with a phosphorescent wheel in the distance.

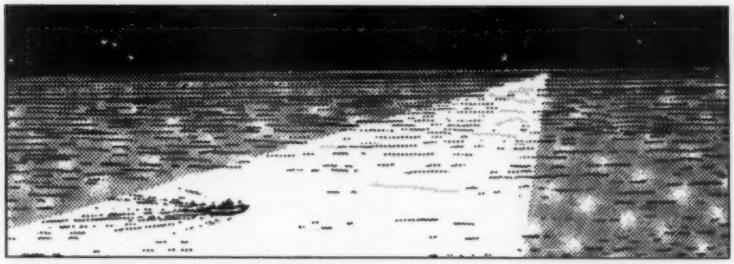
The physical forces that create the auroras and the Andes Glow may be at work near the ocean's surface, unlikely as it may seem. To illustrate this possibility, the luminous mist seen during some low–level auroras closely resembles the aerial phosphorescence seen in some marine displays. Some ship captains have, in fact, noted the similarities between auroral and marine phosphorescent displays. The curious interaction of radar with marine phosphorescence is also suggestive. Another potential explanation would use the collective behavior of marine bioluminescent organisms. Travelers in the tropics, for example, tell amazing accounts of the synchronized flashing of immense assemblages of fireflies. Could marine bioluminescent organisms indulge in similar cooperative action? If so, how do they communicate pattern geometries and why?

Horizon–to–horizon bands of bright phosphorescence in single or parallel array have been observed. The bands may vary from a few feet to a half mile in width. The phosphorescence may be steady or broken up into flashing patches. Blue and green are common colors.

The wide bands of constant brightness might be a different phenomenon than the narrow strips of pulsing patches.

Assuming the light is biological in origin, the geometry and large–scale organization of the display must be explained. In this instance, oceanic internal waves provide a reasonable mechanism for stimulating bioluminescence in long, straight lines where they intersect the surface. Stimulation of bioluminescence by internal waves— especially in the case of the broad lanes of constant brightness might explain these bands. The periodic switching on and off of the bright patches may be influenced by the ship's engines.

A recent issue of the **Marine Observer** contained an interesting report from the m.v. ***Graiglas***: On the 30th of October 1986, between 2130 and 2300 UTC the



One of two parallel corridors of luminescence encountered in the Gulf of Mexico in 1908.

ship was treated to a spectacle of what seemed like underwater fireworks. There was some slight bioluminescence along the ship's side, very close to the hull, but by and large, the majority of the activity occurred in the ship's wake and close to the stern on either side. Neither radar nor echo–sounder were on, so they were flashed up in order to see what effect they had— nothing was noted. The Aldis lamp was flashed into the water to see what happened, this had no effect either.

The activity consisted of very fast and rapid flashes of pale white/blue and white/green of 1 1/2 to 2 seconds in duration. The majority of the flashes started off as a glow which was about 1/2 meter wide, and then grew in intensity and size to about 1 meter before fading away. At any one time there there must have been at least 100 of these flashes and this occurred nearly continuously for the entire period. The explanation given was the possibility of Comb–jellies, among the brightest of luminous animals.

On November 24, 1908 in Gulf of Mexico, a remarkable marinc phenomenon was observed by the steamship ***Dover***, Capt. Yon A. Carlson, as that vessel steamed to Tampa from Mobile. At a point 35 miles from Mobile light, at 7 o'clock in the evening, the ship ran suddenly in a streak of light coming from the water which alternated blue and green, the colors being so brilliant that the vessel was lighted up as if she were covered with arc light with colored globes. A half mile streak of dark water, and a blackness that settled like a pall over the ship followed, then a second streak of the same brilliant–hued waters was encountered. The second streak was about as wide as the first one, and when the ship ran out of it the same black waters and a night of exceptional blackness were also encountered. Each of the streaks and the intermediate streak of black water was about half a mile wide.

This observation from the **Marine Observer**, was taken on July 8, 1977 in the North Atlantic. At 2230 the vessel passed through parallel bands of bioluminescence which were approximately 65 centimeters wide with a distance of about 8 meters between each band; owing to the darkness it was not possible to determine the length of the bands. Each band lay along the direction of the wind which, at that time, was southwesterly. The phenomenon was observed for 12 minutes and it was interesting to note that throughout this time the calls of seabirds could be heard and once or twice they were observed in the glow from the navigation lights. At no other time during the night were these birds heard or observed.

The **Marine Observer** carried this observation from the South Atlantic. "At 0330 UTC in a position 35 miles southwest of the Fernando de Noronha Archipelago the vessel entered a large area of bioluminescence; it took the form mainly of parallel bands, but there were also some patches of white water and some rapid flashes on the sea surface. The bands were about 200 meters apart and they appeared to be about 5 miles in length and about 4 meters in width. They seemed to be moving with the wind in a northwesterly direction. The size of the individual luminous flashes varied in diameter from 15–60 centimeters. A sample of the water was taken and its temperature was found to be 26°C. The glow from the bioluminescence was considerable, so much so that it was not necessary to switch on a torch to examine the sample of sea water taken. The phenomenon was chiefly white in color but there were emerald–green patches on the parallel bands in the wake of the vessel. The vessel steamed about 40 nautical miles before clearing the area of bioluminesence.

Many questions can be asked about marine phosphorescent displays. Why are most concentrated in the Indian Ocean and South China Sea when other seas also teem with bioluminescent organisms? Where does the mysterious underwater lightning called **te lape** by the Polynesians fit in? Unfortunately only a few scientists have deigned to notice this fertile field of research. In the next column we will look at moving phosphorescent bands and wheels.

December Bomb

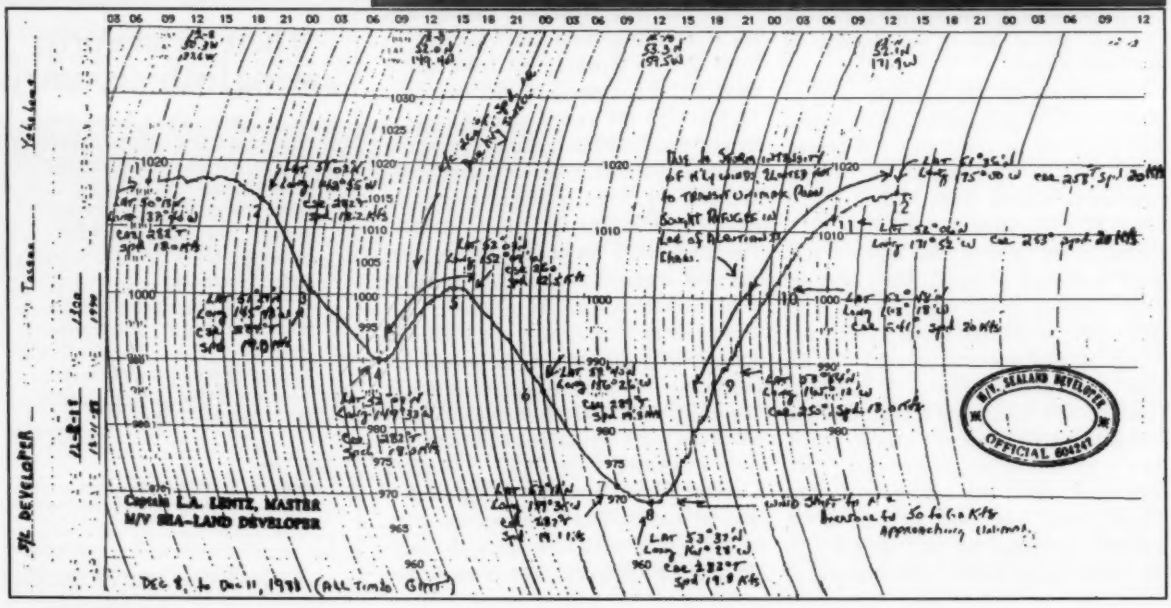
The storm of December 10th that roared north from the mid–Pacific into the Aleutians and Alaska must have been one of your **bombs** or **explosive deepening** that you talk about in the Fall '88 **Mariners Weather Log**. Fortunately for us we sandwiched ourselves between several Lows, although hove to for 9 hours. I saw the next Low to the south intensifying and the San Francisco forecasters indicated a very strong east northeast to east movement, although heading for Unimak Pass (some 24 hours away). I also saw the very strong High blocking system along the west coast of Canada and the USA. As you know the Low deepened rapidly and turned northward. By early on the 10th, on my final approach to Unimak, the wind changed abruptly and came out of the north like gangbusters, gusts to 60 and 65 knots. It is hard to believe that a 47,000–ton plus container vessel can be buffeted by such a sudden change; fortunately, protection from the Aleutian Island chain was not far away. Due to the direction and intensity of the wind I cancelled my passage of Unimak and chose to lay a passage along the south side

of the Aleutian Island chain. The wind and sea were fierce but swell was non–existent.

I thought you might be interested in my barograph chart with position, course and speed. We also went to a 3 hour reporting sequence for awhile. All my voyage observations and a copy of the enclosed will be delivered to Mr. David Bakeman, PMO in Seattle upon our return to Tacoma on January 15, 1989.

Even though ERICA is an Atlantic study on **bombs** or **explosive deepening**, I feel certain that the mid–Pacific, Aleutians and the Gulf of Alaska has a good share of them.

Sincerely,
Lindley A. Lentz
Master, M/V Sea–Land Developer



Service at a Coastal Station 1938-1940

Malcolm Rigby

Fort Canby State Park now occupies the entire Cape Disappointment headland and a 2-mile sand spit; the site of the former (1900-1945) U.S. Weather Bureau station is completely obliterated. The station was moved in the mid-1940's to a more sheltered location across the Columbia River, near Astoria, OR, just as the Tatoosh Island station (WA) was moved to Neah Bay for economy, convenience, and to allow radiosondes and pilot balloons to be launched— impossible on a gale swept headland. The 65–foot–high lighthouse still remains on its original site, however.

One of the special duties at North Head besides reporting every 6 hours by telegraph was to identify (with a large telescope) ships entering the Columbia River, and report them by Morse Code to the Weather Bureau at Portland, OR. Of course with most ships having radio communications by 1940, this service was redundant and was discontinued, since it was not as vital as it was in the early part of the century when sailing vessels (coming from *Down Under*) might not have been seen or heard from for 3 months or more.

But in the meantime, North Head had become a representative or *Key Station* for reporting violent North Pacific frontal pasages, which, before the days of satellite imagery, could not be pinpointed as to time and severity until they hit North Head. Such a passage might occur just after a 6–hourly report had been telegraphed, thus justifying a *Special Observation* (by telephone in the event the telegraph line was down as it often was during a gale). The fact that the *front* had passed would be very useful to the synoptic chart analysts at the Portland and San Francisco forecast centers, who could thus pinpoint the exact location, time, and severity of the front or gale and not forecast its advent after the front had already passed a station or airport.

The anemometer was on a 50–foot tower, 200 feet above the sea. On January 21, 1921, it produced a record of 150 mph (uncorrected) before the instrument was carried away by the secondary *hurricane–force* cyclone.

This record was analyzed by Marvin Magnuson, who sent me a copy of his design analysis made for the Washington State Highway Engineers in the early 1960's when they were preparing to build a bridge across the Columbia River to Astoria, OR. The 4-cup anemometer (then in use) had an inertia factor that, at such high speeds, gave a reading 37 mph too high, so the corrected value, for that height, was 113 mph. However, since the anemometer blew away, the actual wind might have been greater.

The following data are extracted from this 3-page report:

Estimated Maximum Winds at North Head (1902-52)

Return Period	Fastest Mile	Fastest 5 min. Average
10 years	87-95 mph	79 mph
25 years	92-101 mph	84 mph
50 years	97-106 mph	88 mph
100 years	101-110 mph	92 mph
200 years	106-115 mph	96 mph

The United States Weather Bureau Station at North Head (left) is now obliterated. Here whole gale storm signals are flying with heavy surf. The North Head Lighthouse was featured on the cover of the August 1987 ***Smithsonian*** *magazine. The article inside detailed the effort to preserve or renovate historic lighthouses along the coastal areas of the U.S. This photograph was taken by Malcolm Rigby who, along with his wife Marian, was stationed at North Head from 1938 to 1940. He considers it one of the best experiences of his 55–year marriage.*

Use that Camera

Being at sea with a camera, offers an opportunity that many amateur or professional photographers never get. The weather and oceanographic phenomena encountered often create settings for dramatic and sometimes unique photographs. Taking a snapshot is relatively easy. With a little effort a snapshot can be turned into a quality photograph.

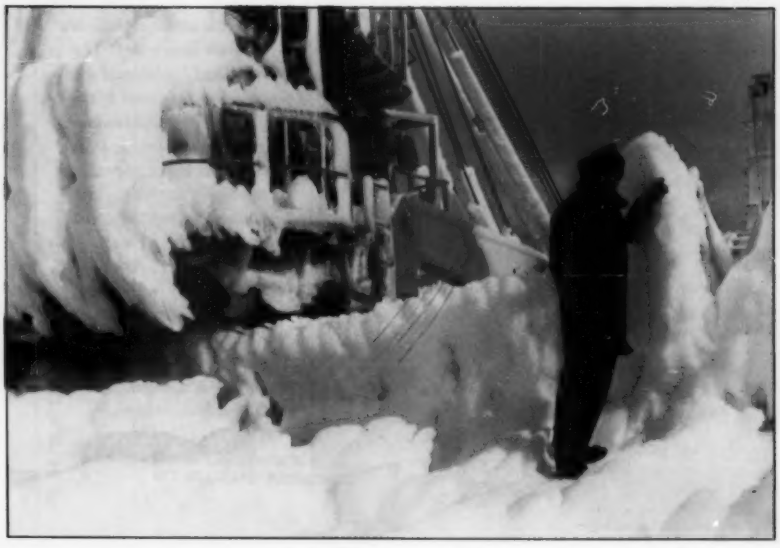
Over the years we have received a great number of photographs from mariners. These include shots of waterspouts, thunderstorms, waves ice, and superstructure icing. We have also received many questions on shooting pictures at sea. In this column, in the future, we hope to answer questions, publish good photographs and carry articles by experienced professional and amateur photographers with tips they are willing to share.

We hope to use Coast Guard, Navy and NOAA photographers to answer questions and provide information on such topics as film speed, filters, care of equipment and stability problems. In addition we are planning a piece on underwater photography.

If you take or have taken a photograph that contains interesting oceanographic or atmospheric phenomena we encourage you to send it in— either a print, slide or negative. They will be handled with care and returned. In addition to waves, thunderstorms, lightning and ice there are shots of dramatic cloud formations, sunsets and sunrises, lighthouses, unusual navigation aids, radar scopes, northern and southern lights that we would like to publish. The need is there for good photos. For example, in this issue in the column on bioluminescence we could not find a good photograph. If you have a question on photography at sea, we will find someone who can answer it. The address for submissions and queries is:

Mariners Weather Log (E/OC21)
National Oceanographic Data Center, NOAA
Washington, DC 20235

Montage of past photographs from shipboard photographers



Narragansett Bay Revisited

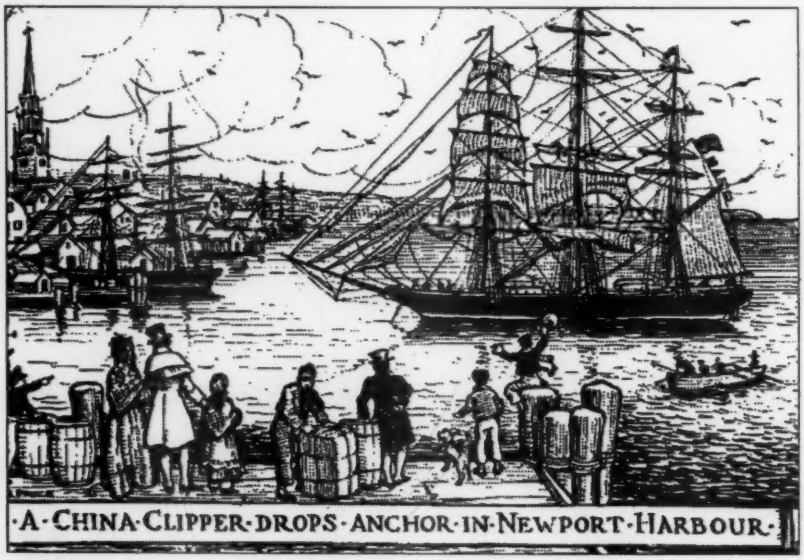
Stuart Hale's popular *Narragansett Bay; A Friend's Perspective* has been updated and released in a second edition. When originally released, the book was the winner of eight publication and design awards.

The second edition traces the developments that have occurred in and around Narragansett Bay over the last decade. The 130–page book contains some 150 illustrations with many historical photographs, engravings and maps. The front cover of the book is an antique–postcard scene of local beach–goers in Victorian costume. The reverse side of the postcard is featured on the back cover, complete with handwritten message and one–cent stamp.

When first released, the design was one of 183 winners selected from 1300 entries for a Greatest Covers in the World exhibit. The exhibit toured 11 cities around the world in 2 years. Other winning entries included *Time*, *Newsweek*, *Playboy* and *National Geographic*.

The updated edition has been released as part of Rhode Island Sea Grant's 20th anniversary celebration. It is available from Rhode Island Sea Grant for $15. Sales of the book help underwrite other free or low–cost Sea Grant publications available to schools and the public. To order *Narragansett Bay: A Friend's Perspective*, or to receive a list of Sea Grant's many other publications, write to:

Publications, Rhode Island Sea Grant
University of Rhode Island Bay Campus
Narragansett, RI 02882–1197



One of many sketches, engravings and woodcuts from the Newport Historical Society, contained in Narragansett Bay: A Friend's Perspective. The book is divided into three major sections dealing with the Living Bay (topography, geology, winds, tides and living creatures), The Bay in History and Modern Times. There is also a look to the future and an excellent reference section. The illustrations are worth the price of the book alone.

Help for SOS

The United States has joined 65 other maritime nations in adopting a new radio communications system that will improve safety and all but replace Morse code at sea. The Global Maritime Distress and Safety System (GMDSS) comprises sophisticated satellite and land–based radio services and should greatly improve the safety of life and property as sea according to U.S. Coast Guard officials. The system's equipment can send an automatic distress call or locate ships in distress even when the radio operator is unable manually to send a mayday call.

GMDSS will change the international distress communication from primarily ship–to–ship to ship–to–shore. For the first time ships will be required to receive broadcasts of maritime safety information that can help prevent problems before they happen. Voice or text messages will be transmitted by electronic devices. The Coast Guard, the Federal Communications Commission, the Defense Mapping Agency, other government agencies and the marine industry jointly developed the new system over a 10–year period. The new system was adopted during a 2–week conference at the London headquarters of the United Nation's International Maritime Organization in early November. The conference, with delegations representing 97 percent of the world's shipping, considered amendments to the 1974 International Convention for the Safety of Life at Sea. Individual nations have one year if they wish to state objections to the amendments, after which they automatically go into effect. The amendments, which include the new system, apply to cargo ships of 300 tons and over, as well as all passenger ships, on international voyages.

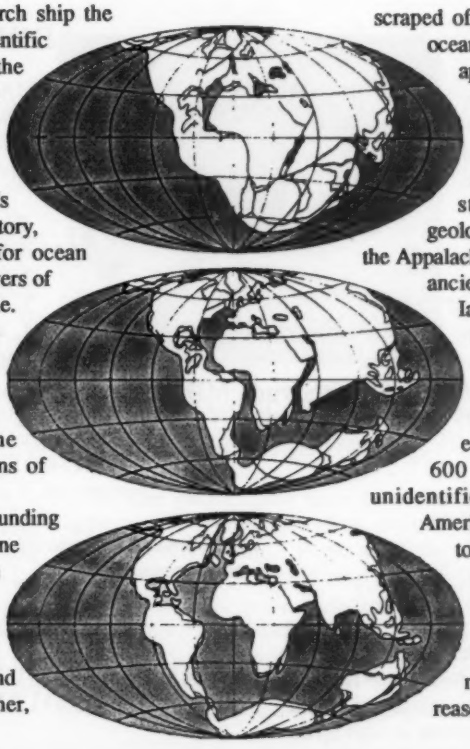
We would like to hear from the Radio Operators on what they think of this new system. They are not only responsible for the safety of the vessel but for maintaining the equipment and operating the communications gear. Will this replace Morse Code? **–ed.**

Last Voyage— in Search of an Ancient Continent

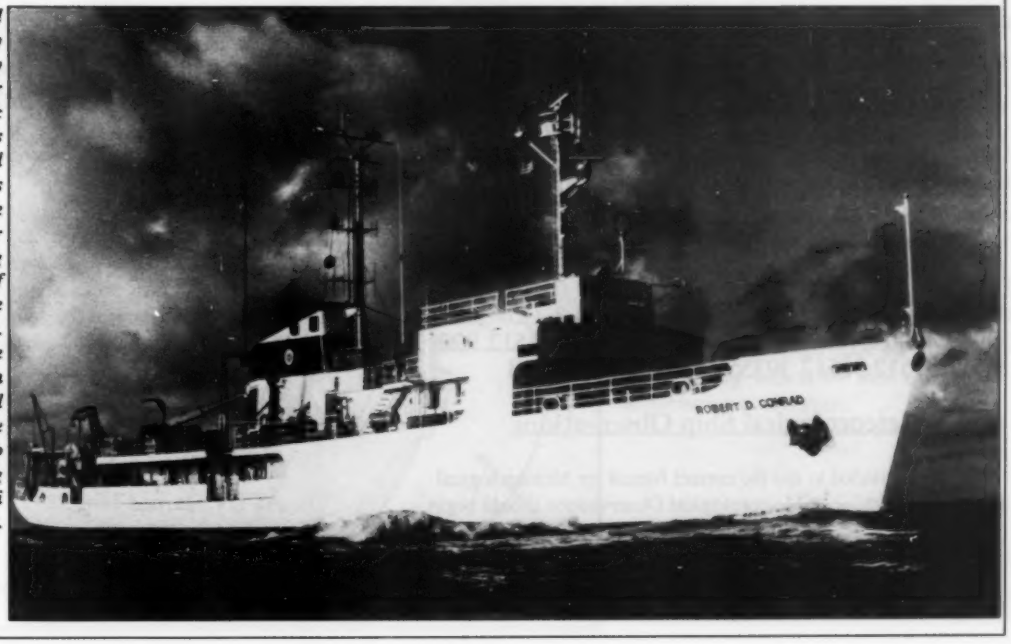
Columbia University's famed research ship the ***Robert D. Conrad*** made her last scientific voyage on April 6th by sailing up the Hudson River in search of ancient continents. After the voyage the ***Conrad*** will be returned to the U.S. Navy.

The ***Conrad***, operated by Columbia's Lamont–Doherty Geological Observatory, used new technologies developed for ocean exploration to probe deeply buried layers of Hudson Valley rock for the first time. Columbia scientists will search the stacked and crumpled rock for clues, including embedded remnants of an ancient ocean floor, to explain how colliding continents formed the Appalachian Mountains over millions of years.

Trailing an array of underwater sounding devices and a streamer of hydrophone receivers a mile and a half long, the ***Conrad*** used sound waves to penetrate up to 20 miles down into myriad layers of sea floor rocks, volcanic islands, coastal sediments and continents. All were pushed together, scraped off, scooped up and piled high when an ocean opened and closed and continents split apart and smashed together again. Like knives cutting into marble cake to expose enfolded layers of varying shapes and colors, the sound waves should reveal images of assorted rock strata. Those images will allow geologists to study the geologic evolution of the Appalachians. They expect to see vestiges of the ancient supercontinent of Pangaea and the Iapetus Ocean floor, which existed before the modern Atlantic.



The scientists expect the multi–channel seismic techniques to provide strong evidence of the geologic evolution of the mountains, which began 600 million years ago when an as yet unidentified continent was attached to North America. At that time the Earth's plates began to move in opposite directions, creating a rift that formed an ancestral Atlantic, called the Iapetus Ocean. But once oceans open, they are not permanent features. The Iapetus grew for 140 million years and then began to close, for reasons scientists do not know.



*The **Robert D. Conrad** was originally built by the U.S. Navy specifically for oceanographic research some 26 years ago. She has logged over 1 million miles since that time. The **Conrad** launched her reputation by locating the sunken remains of the nuclear submarine **Thresher** in 1963. Since then the 208–foot, 1,000–ton ship has crisscrossed the globe from the arctic North Atlantic to the sea ice surrounding Antarctica, from Tahiti to the Red Sea.*

Selected Worldwide Marine Weather Broadcasts

The 1988 edition of **Selected Worldwide Marine Weather Broadcasts** is available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

The cost is $9.00. Please refer to stock number **003–017–00534–8** when ordering. If your vessel is in the VOS program you can obtain a free copy from a PMO.

Please send any changes to the publication **Selected Worldwide Marine Weather Broadcasts** to the following address:

National Weather Service
International Telecommunications
Section W/0S0151 ROOM 419
8060 13th Street
Silver Spring, MD 20910

In addition addresses/ telephone numbers are needed to inform you of the next printing of **Selected Worldwide Marine Weather Broadcasts.** Our intent is to send a letter to each of you, requesting that you provide us with updated schedules for the 1989 edition. Please send this information to the above address.

BATHYTHERMAL/TESAC Observations

Ships are reminded to use the correct format for Bathythermal/Tesac Observations. Bathys/Tesac should start with **JJXX** and end with the **Call Sign**.

EXAMPLE: **JJXX** 20106 0312/ 74519 05528 88888 00098 26097 28098 29094 33069 36044 37026 38014 39009 41004 46503 48505 59508 84512 9901 36512 37512 38512 39355 46355 0000 **VCTB**

Meteorological Ship Observations

Ships are reminded to use the correct format for Meteorological Surface Observations. Meteorological Observations should begin with the **Ship's call sign.**

Julie L. Houston
National Weather Service
Silver Spring, MD 20910

INMARSAT Reports Procedure

INMARSAT equipped ships may transmit weather messages using the following procedures after the message is composed off-line:

1. Select U.S. Coast Earth Station Identification CODE 01.
2. Select routine priority.
3. Select duplex telex channel.
4. Initiate the call.
   Upon receipt of GA+ (Go Ahead).
5. Select dial code for meteorological reports, 41, followed by the end of selection signal, +.

41+ (or 00 23 6715250+)

6. Upon receipt of our answerback, NWS OBS MHTS, transmit the ships call sign and the weather message only. Do not send any other preamble.

INMARSAT Format Example

WLXX 29003 99131 70808 41998 60909 10250 2021/ 40110 52003 71611 85264 22234 00261 31100 40803 ....

Coastal Radio Station Example

WLXX 2900399131 7080841998 6090910250 2021/40110 5200371611 8526422234 0026120201 3110040803

Available

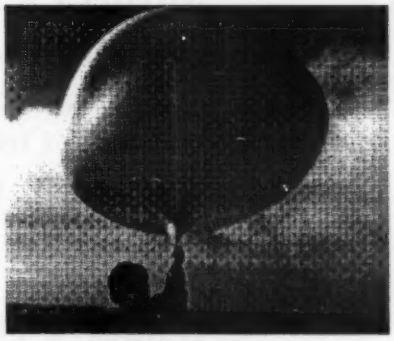
Information concerning Coast Earth Station ID codes and Telex and Telephone Country Codes can be found in the INMARSAT Users Guide. The Users Guide is available at the address below:

COMSAT Maritime Services
950 L'Enfant Plaza, S.W.
Washington, DC 20024

ATTN: James Jansco

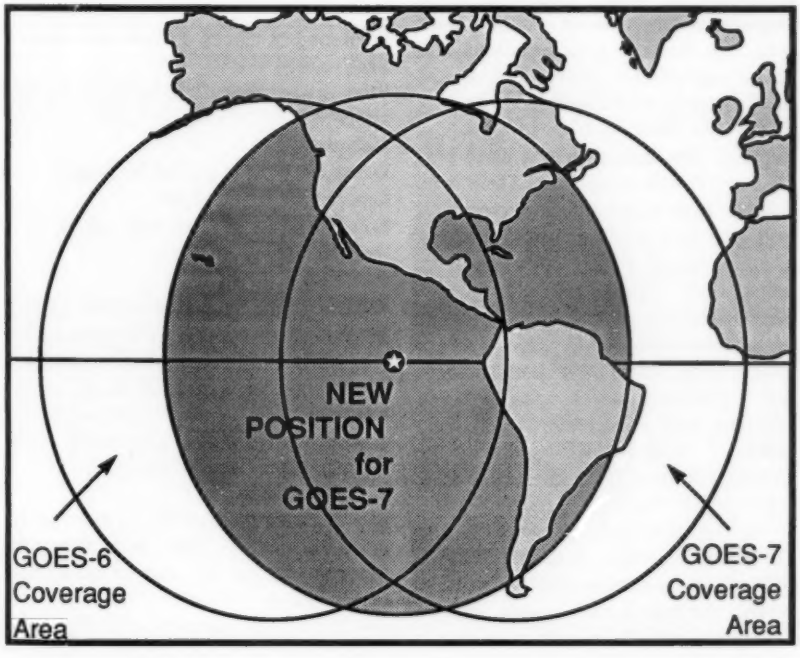
GOES West Goes East

The Imager on GOES 6, which provided satellite cloud photos over western North America and the Pacific Ocean, failed January 21, 1989, after having provided data for 6 years. GOES 6 was one of two United States Geostationary Operational Environmental Weather Satellites (GOES), located 22,000 miles above the equator, with a photographic capability. To compensate for the loss, GOES 7 (GOES East) has been moved farther west to 108.5°W and renamed GOES Central. The data collection and communications capability of GOES 6 is still functioning normally. Data from buoys and SEAS (Shipboard Environmental Data Acquisition System) units, weather facsimile products and a variety of other meteorological and oceanographic data are relayed with the GOES data collection system. No satellite will be available as a replacement until early 1991, when the first new generation of GOES satellites are expected to be ready.



Martin S. Baron
National Weather Service
Silver Spring, MD 20910

Satellite photography over the ocean supplements, but does not replace, the ship weather observations. Even when the satellites are fully functional, ship data are necessary for the basic meteorological analyses used to predict weather. Only ships provide data on sea level pressure, wind, temperature, and actual weather conditions, which are needed to prepare surface weather charts and accurately locate isobars, fronts, high and low pressure systems and areas of active weather. Satellite photos help locate frontal boundaries, tropical weather systems and other convective cloud activity; they are also used to estimate the intensity of these systems. There's no telling how long GOES 7 (now called GOES Central) will last— if she fails before the new generation satellite is ready, ships will become, as they were in the past, the sole source of data over vast ocean areas of the earth.



First Annual VOS Awards

We are pleased to announce that 22 vessels have been selected to receive awards for weather observations taken during 1988, the first year for the Voluntary Observing Ship awards program. The awards plan recognizes the very best and most conscientious weather reporters, and only about one percent of all VOS program ships will be honored. Vessels have been chosen that follow recommended reporting schedules, and meticulously take and encode the weather message data groups. Sending observations on time has also been an important selection criteria. There is no specific number of observations to qualify— although several very diligent vessels receiving awards did transmit over 1000 observations each. Special Top Ship selection has also been made for providing the National Weather Service with particularly outstanding support. This will be announced in the next issue of the Mariners Weather Log. The entire marine observations program staff congratulates the following vessels for their exceptional performance as observers.

Outstanding Performance Awards, 1988

Arthur M. Anderson
Atigun Pass
Belle River
Charlotte Lykes
Chevron California
Chevron Mississippi
Edward L. Ryerson
Great Land
1st Lt. Jack Lummus
USCGC Jarvis
Merida
Moana Pacific
Mormac Star
NOAA, Mt. Mitchell
NOAA, Oregon II
NOAA, T. Cromwell
Oleander
Polynesia
Rainbow Hope
Sea Lion
Thomas Washington
Westwood Jago

New Recruits for January–March 1989

Port Meteorological Officers recruited 29 vessels into the VOS program during January, February and March 1989. Thanks for joining the program. Your Port Meteorological Officer will present you with a framed VOS Program membership certificate, which is usually hung on the bridge or in the chart room. Please remember that the basic worldwide weather reporting schedule for ships is four times daily— 0000, 0600, 1200, and 1800 UTC. Also you should send a special report using the prefix SPREP before the call letters in the weather message, if you should encounter weather conditions that have not been forecast. The United States and Canada have a 3–hourly reporting schedule in effect on the Great Lakes and from within 200 miles of the U.S. and Canadian Atlantic, Pacific and Gulf of Mexico coastlines. Please follow the reporting schedule as best you can. All reports are voluntary.

The new edition of Selected Worldwide Marine Weather Broadcasts, dated November 1988, is now available from the PMO's. This publication contains the schedules of English language weather broadcasts, and includes data on broadcasts in other languages when English broadcasts are not available in the area. To find out which stations will accept your weather observations, see the publication Radio Stations Accepting Ships' Weather and Oceanographic Reports. The latest edition is dated May 1986 and is still up–to–date. There is no cost to your vessel or shipping company if you transmit weather reports using stations listed in this book. Billing arrangements already exist between these stations and the various Meteorological services around the world. Reports should be sent to the United States Radio Stations when you are operating within our forecast and warning areas: Pacific Ocean— from 160°E eastward to the coast and north of 25°S; Atlantic Ocean— from 35°W westward to the coast, including the Gulf of Mexico and Caribbean Sea, and north of 3°N. Outside of these areas, weather reports should be sent to the nearest radio station, or to a station in the country that is preparing forecasts for the area.

Marine Humor Corner

What kind of money do fishermen make?
Net Profits.
Who is always getting let down by his mates?
A deep sea diver.
Where can most of the fish be found?
Between the head and tail.
How do you get in touch with a shark?
Drop him a line.

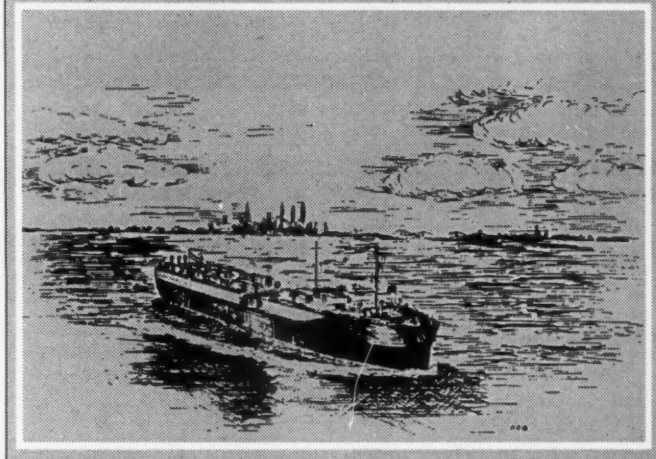
If you send me a publishable joke relating to marine activities, I'll try to print it with your name and title, when space permits. Please send your material to me at the National Weather Service— using the mailing address on the inside back cover of the Mariners Weather Log.

Ed. Note: These jokes do not necessarily reflect the sense of humor of the Mariners Weather Log, but only that of the author of this column.

New Recruits— January–March, 1989

Nada 2	ELAV2	Matson Navigation Co.
Coastal Star	KUS5946	Icile Sea Foods
Fiona Mary	3EQW3	Vermilion Overseas Management
Stella Lykes	WJGH	Lykes Brothers SS Co.
California Hermes	3EZZ6	Matson Navigation Co.
Silver Clipper	ELFD	Strachan Shipping Co.
President Adams	WRYW	American President Lines
Sealand Economy	WNDJ	Sealand Service Inc.
CGM California	XYCX	Kerr Steamship Co.
Margrethe Maersk	OYSN2	Maersk Line
White Rose	3EIS3	Kerr Steamship Co.
Ocean Lucky	DZHK	Fritz Maritime Agency
Hajin Keelung	3EDA5	Hajin Container Line, LTD
Spring Eagle	3FEV2	Kobe Kisen Kaisha, LTD
California Zeus	3EAB7	Matson Navigation Co.
Coronado	KPSB	Keystone Shipping Co.
1st Lt. Baldomero Lopez	WJKV	American Overseas Marine Corp.
Tohzan	3ENR5	Rainbow Maritime Co., LTD
Corah Ann	6YSA	Southern SS Agency Inc.
Casuarina	C6DY8	EAC Transport Agencies
Nedlloyd Van Cloon	DPSI	Nedlloyd Lines
Wilhelm Schulte	P3EU	Transpacific Trans. Co.
Manila Prosperity	DVHB	Kokusai Kisen Kabushiki Kaisha
Argus Explorer	ASWA	Union Shipping Corp.
Orion Highway	3EHO3	Stevens Shipping Co.
USCGC Thetis	NYWL	U.S. Coast Guard
Global Wing	H3ZU	Strachan Shipping Co.
Star Esperanza	DVFP	Star Shipping Inc.

Ships for Victory Reunion



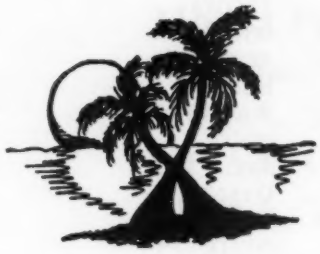
Did you serve aboard or help build a Merchant Ship during WW II? If so, you are invited to a reunion at the U.S. Merchant Marine Academy at Kings Point, New York:

Date: October 27–28, 1989

Dinner Friday and Lunch Saturday

Contact:

Frank Braynard, Museum
U.S. Merchant Marine Academy
Kings Point, NY 11024–1699



Central North Pacific Tropical Cyclones, 1988

by Andy Chun
Eastern North Pacific
Hurricane Center
Honolulu, HI 96820

Four tropical cyclones were tracked by the Central North Pacific Hurricane Center in 1988. Two, Uleki and Wila, developed in the region (between 140°W and the International Dateline) while two from the east moved in during their latter stages.

Tropical Depression Gilma
July 30 – August 3 1988

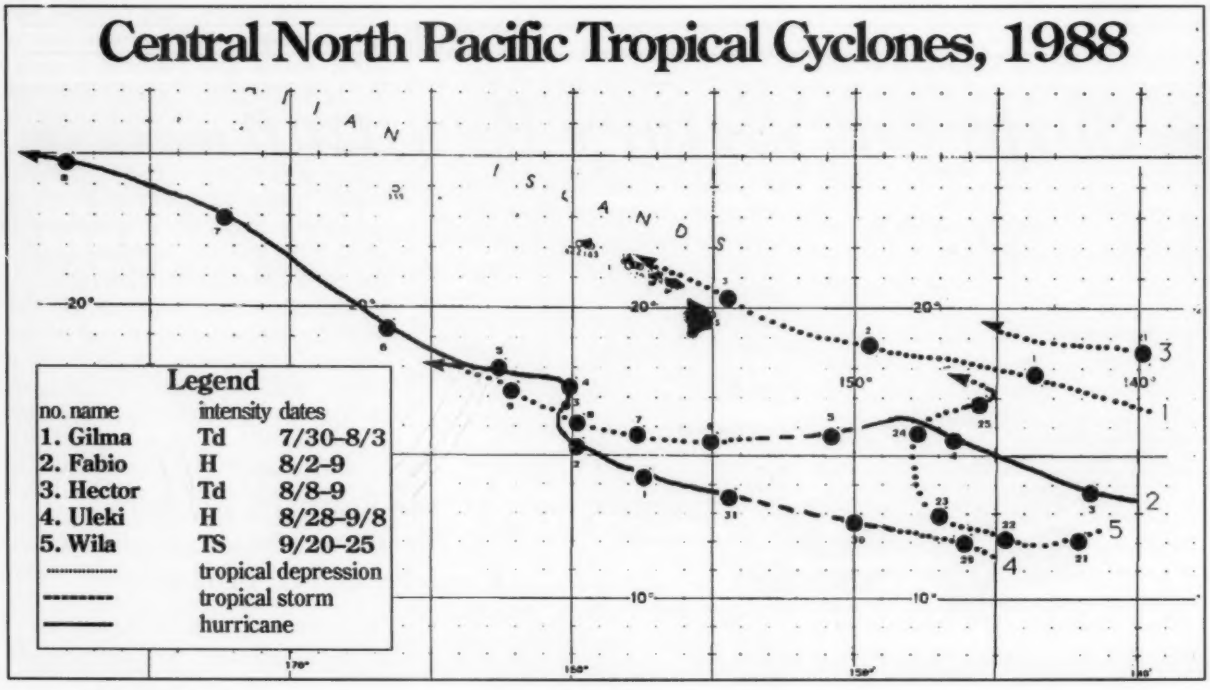
Tropical Depression Gilma was weakening, with maximum sustained surface winds estimated at 30 knots, as it entered the Central Pacific Hurricane Center's (CPHC) area of responsibility during the evening of the 30th. Gilma was one of four tropical cyclones that formed about the same time. The National Hurricane Center began to issue advisories on TD 7E (Emilia), 8E (Fabio), 9E (unnamed), and 10E (Gilma) within a period of 6 hours on the 28th. Gilma and Fabio moved westward and eventually crossed over into the CPHC's area of responsibility.

Gilma, over relatively cool sea surface temperatures, moved in a west northwesterly direction up the windward side of the main Hawaiian Islands. The center of the weakening depression moved very close to the islands of Maui and Molokai the evening of the 2d. Gilma was in a dissipating mode as she glided pass Oahu and Kauai early in the morning August 3d. The circulation consisted mainly of low and middle clouds. Some welcome rain fell over the islands of Kauai and Oahu, where locally heavy amounts in the 2 to 4 inch range were reported.

Hurricane Fabio
August 2–9, 1988

Fabio crossed into the central Pacific on the 2d as an intensifying hurricane with maximum winds estimated at 85 knots. Fabio intensified farther south and west than most mid–season tropical cyclones and posed a real threat to the Hawaiian Islands. At 1200 on the 3d, maximum winds reached 120 knots. This proved to be its peak as upper level flow became less favorable.

Air Force reconnaissance aircraft flew into the hurricane at 0000 on the 4th and estimated maximum winds at 95 knots as Fabio moved steadily toward the islands. However, on the 5th the rapidly weaken-



Volcano National Park, located on the Big Island of Hawaii, was the scene of heavy thunderstorms duing Hector. Lightning was reported to have struck two people in the park.

ing cyclone veered westward. Its center passed about 210 nautical miles south of South Point at 1200 on the 6th as a tropical depression. Some high surf was reported along the black sand beaches on the southeast coast and some heavy showers with rainfall amounts in the 12 to 18 inch range fell near Hilo.

Satellite pictures indicated some strengthening as Fabio passed southwest of the islands on the 7th and 8th . The outer fringes of the depression interacted with an upper level trough to generate some heavy showers over Kaui on the 8th. Fabio weakened again but the remnants were tracked for several more days and could be seen crossing the International Dateline on the 12th at 1800.

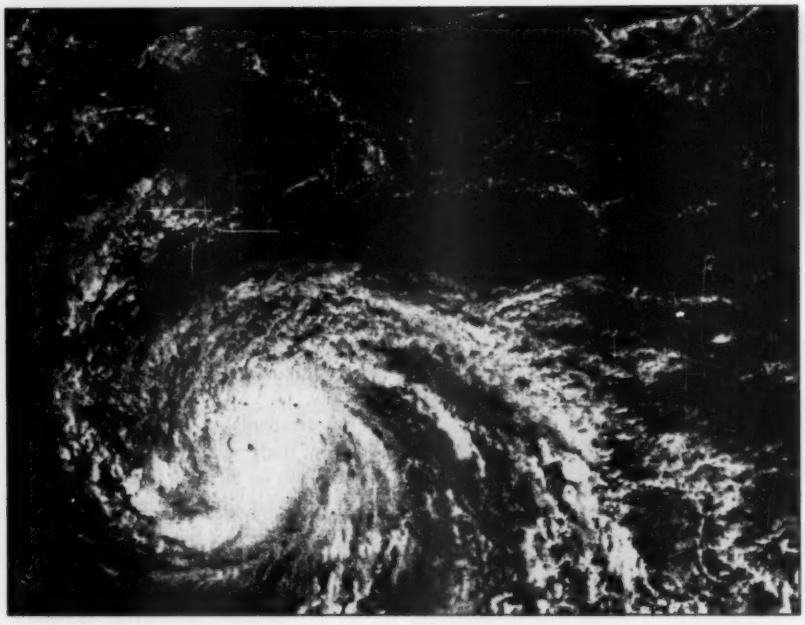
Tropical Depression Hector
August 8–9 1988

Tropical Depression Hector (11E) had been a small but intense hurricane as it moved westward along 18°N and over relatively cool waters east of 140°W. Hector crossed 140°W at about 0000 on the 9th as a rapidly weakening tropical depression. The weakening trend continued as the depression made its way westward and the CPHC issued its final advisory at 1800 on the 9th when the remains of Hector were centered near 19°N 145°W.

The remnants of Hector were carried along by trade winds into the Hawaiian Island chain on the 11th and caused some heavy showers on the islands of Kauai, where more than 6 inches of rain fell in the mountains and locally along the north shore. At the same time, moisture from tropical disturbance passing to the south of Hawaii made its way northward and caused some heavy thunderstorms over the Big Island, where lightning in the Volcano National Park area was reported to have struck two people. In both cases, the warm moisture air associated with the tropical systems interacted with a cold upper level trough to cause an outbreak of convection near and over the Hawaiian Islands.

Hurricane Uleki
August 28 – September 7, 1988

As August drew to a close, activity along the ITCZ southeast of the Big Island of Hawaii showed signs of development and was tagged Tropical Depression (TD) ONE–C on August 28th. It moved westward while intensifying and was upgraded to a tropical storm Uleki at 1800 on the 29th. Uleki continued to intensify and was upgraded to a hurricane, about 350 nautical miles south of Hilo, Hawaii. During the next 12 to 18 hours Uleki experience explosive intensification with winds estimated by Air Force Hurricane Hunters to be 100 knots at 1800 UTC on the 31st. Maximum intensity was reached when wind speeds near the center were estimated to be 110 knots at 0000 on the 2d. Up until this time, Uleki moved at a fairly steady rate toward the west. However, on the 2d and 3d, Uleki stalled



Hurricane Uleki at 1846 UTC on the 31st is located nearly 300 miles south southwest of the Big Island of Hawaii. Maximum winds at the time were about 100 knots.

and began to drift slowly northward.

The people of Hawaii experienced some anxious moments when Uleki stalled so close to the Islands. It was extremely helpful to have aerial reconnaissance available to continuously monitor the position and intensity of the threatening cyclone. U.S. Air Force reconnaissance crews flew a total of 10 missions and provided 41 center fixes on Uleki between August 31st and September 5th. Estimated maximum sustained surface winds of 110 knots were observed between 2026 on the 1st and 0028 on the 2d. The lowest sea level pressure determined by dropsonde was 957 millibars at 1528 and 2306 on the 2d.

A Tropical Storm Watch was issued for the islands of Niihau, Kauai, and Oahu at 0000 on the 3d as Uleki floundered around to the southwest of the Hawaiian Islands with 100–knot winds. Uleki described several small loops while drifting northward prior to resuming its west northwest movement early on the 4th. There were no effects on the weather over the Hawaiian Islands. Uleki's circulation did produce some swell which caused high surf along the southern shores of the Hawaiian Islands— especially on the islands of Kauai and Oahu. Two drownings on Oahu were attributed to the rough water.

Uleki experienced a slow weakening trend as it paused to the southwest of the Islands. This trend continued as the once powerful hurricane moved westward passing north of Johnston Island and south of French Frigate Shoals during the evening of the 5th. The weakening of Uleki stopped during the evening of the 6th as a favorable upper flow and warmer sea surface temperatures caused reintensification with winds increasing to 90 knots.

Continuing west northwestward, Uleki passed about 200 nautical miles south of Midway Island at 0300 on the 8th. Maximum winds recorded were 090–120° at 22 knots gusting to 31 knots at 0101 on the 8th. Midway reported the southeast shoreline as having the most wave action with waves breaking over the runway.

The CPHC passed warning responsibility to the Joint Typhoon Warning Center (JTWC) at 0000 on the 8th and Uleki became a typhoon. It remained an intense typhoon west of the dateline for several days while meandering near 30°N, 165°E.

Tropical Storm Wila
September 20–25, 1988

Wila was the second tropical cyclone to develop within the CPHC area of responsibility during the 1988 season. The first advisory on Tropical Depression TWO–C was issued at 0000 on the 21st, as an area of convection near 12°N, 142°W showed signs of development. TD TWO–C was, however, slow in getting organized. It drifted slowly, first westward and later northwestward, over the next day or two, with winds estimated at 25 knots near the center. The deep easterly flow in which the depression was embedded turned to the southwest at higher levels as a trough in the westerlies approached. This caused TWO–C to recurve toward the northeast at about 1800 on the 23d near 15°N, 148°W. Some intensification was confirmed by an Air Force reconnaissance plane investigating the circulation, which measured winds of 40 knots near 17°N, 145°W. Based on the observations received from the reconnaissance aircraft, TWO–C was upgraded to a tropical storm at 0000 on the 25th and named Wila. At this time, the vertical wind shear over the circulation was quite large. This caused the lower portion of the storm to start moving westward toward the Hawaiian Islands while the top portion blew eastward with the upper level westerlies. Wila's life as a tropical storm was short lived—18 hours— as the system, now void of any deep convection, quickly weakened and Wila was downgraded to a tropical depression. Moisture carried along with the remnant circulation produced a few heavy showers over the Hawaiian Islands on September 26th and 27th.

SPECIAL NOTICE

OCEANOGRAPHIC ATLAS of the INTERNATIONAL INDIAN OCEAN EXPEDITION

by Klaus Wyrtki

The National Oceanographic Data Center (NODC) is pleased to announce that the *Oceanographic Atlas of the International Indian Ocean Expedition* by Klaus Wyrtki originally published in 1971 by the National Science Foundation has been reprinted by Amerind Publishing Co. in India. Based on all available data from the Indian Ocean collected from the mid-1920s to 1966 (with the exception of a few cruises omitted for various reasons), the Atlas had been unavailable since the initial printing was exhausted. The Atlas displays major oceanographic variables in color-coded maps; it contains 531 pages (15 1/2 x 12 inches.) Copies of the reprint are now available from the NODC for a mailing and handling fee of $15.

Orders must be prepaid by check, money order, or credit card (Visa and MasterCard only). Purchase orders can be accepted only with prior authorization from the NODC. Credit card orders must include the card number, expiration date, and name of the card holder exactly as it appears on the card. Checks and money orders should be made payable to "Dept. of Commerce/NOAA/NODC"; payments must be in U.S. dollars and drawn on a bank located in the United States. Orders should be directed to:

National Oceanographic Data Center
User Services Branch
NOAA/NESDIS E/OC21
Washington, DC 20235

Telephone: 202-673-5549

ORDER FORM YES. Please send me the *Oceanographic Atlas of the International Indian Ocean Expedition.*

TOTAL COST: No. of copies _____ x $15.00 each = $ _____

❑ Check/money order enclosed for $_____ ❑ Purchase order enclosed (#_____)

Charge my: ❑ VISA ❑ MasterCard Credit Card #_____

Exp. Date _____ Daytime Phone _____ Signature _____

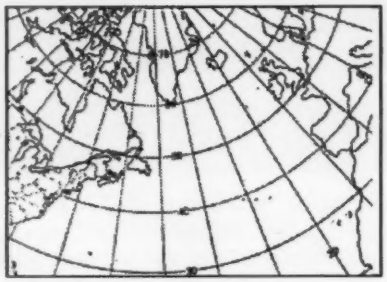
SHIP TO: Name _____

Address _____

_____

City _____ State _____ ZIP _____ Country _____

National Oceanographic Data Center, User Services Branch, NOAA/NESDIS E/OC21, Washington, DC 20235



North Atlantic Weather Log October, November and December 1988

October— You may remember that in August the Icelandic Low was reminiscent of October. Well the favor was returned this month. From the looks of the October pressure pattern (fig 1), you'd swear that there was an August Azores–Bermuda High. Usually by October the Icelandic Low is the major topic of conversation among climatologists. And even this feature was deeper and farther south than normal. So the eastern North Atlantic negative anomalies were the rule while the west produced positive anomalies. The Azores–Bermuda High seemed to be the result of a few large slow–moving anticyclones spread throughout the month. Several moved from off the mid Atlantic coast of the U.S. The misplaced Icelandic Low was the product of numerous cyclones of moderate intensity between Greenland and the Bay of Biscay.

In the steering level at 700 mb, a pattern of a trough over eastern North America, a ridge in the central North Atlantic and a trough over the eastern North Atlantic reflected the surface features. This pattern set up sort of a sine wave pattern. A storm that followed this pattern might move New York to the English Channel but not on a straight line. It would travel across Nova Scotia, dip south to west of Cape Finisterre and then into the Channel.

On This Date— October 17, 1950— A small but powerful hurricane (King) struck Miami. The hurricane packed winds up to 106 kn and caused $128 million damage.

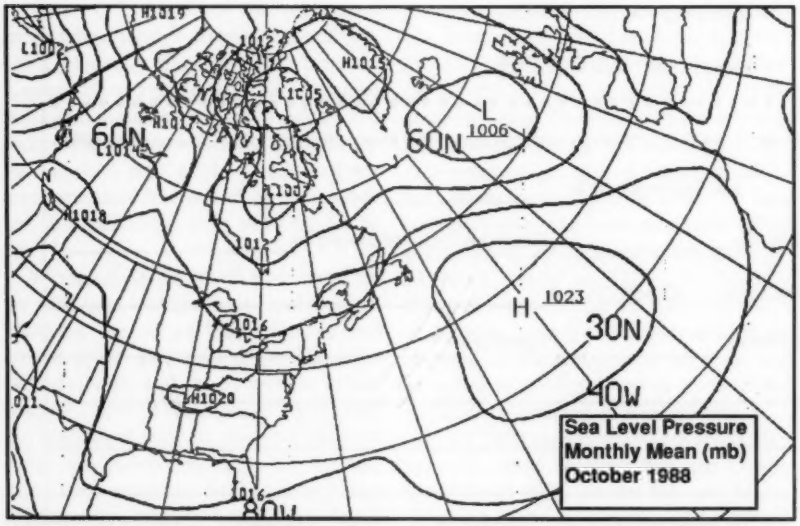


Figure 1.— Summertime in autumn according to the average pressure chart for the month of October. Note the Azores–Bermuda High.

Extratropical Cyclones— There were a large number of storms this month but most were of the weak or moderate variety. As indicated by the position of the Icelandic Low the waters of the eastern North Atlantic were quite active.

There were two storms of particular interest to Great Lakes mariners. The information for these systems was provided by Daron Boyce the Marine Focal Point for the Weather Service Forecast Office at Cleveland.

❶ The first storm resulted in a warning for Lake Superior issued on the morning of the 10th. The system can be traced back to the 7th just east of Lake Winnepeg. It swung southward then curved northward after crossing southern Lake Michigan on the 9th. By 1200 on the 9th a 1017–mb center was analyzed just east of Milwaukee. Showers were popping up to the east and southeast. At 1800 winds of 40 kn or more were reported by several stations and vessels, including ***Mesabi Miner***, on Lake Superior, Wolverine and Presque Isle, MI, on Lake Michigan; on Lake Erie the AES Platform 45134 and Baie St. Paul also reported 40–kn winds. At 2100 Point Petre, ONT reported in with 41–kn southwesterlies that gusted to 53 kn.

As the center moved slowly southeastward pressure fell slightly to 990 mb by 2100 on the 10th. The WYQ (47.8°N, 89.1°W) encountered 34–kn west northwesterlies while the WZE hit 45–kn winds in 10–ft seas on northern Lake Michigan. The system (fig 2) moved slowly toward the east northeast. By the 11th at 1200 the center was in eastern Quebec near Baie Comeau.

❷ The second Great Lakes storm was picked up on the 26th near Moose Jaw, Saskatchewan. The first warning from Cleveland was issued that afternoon and indicated storm force winds (48 kn or more) over portions of the upper Great Lakes. At 0600 on the 26th a 996–mb Low, centered over northern Minnesota, began to swing toward the east north-

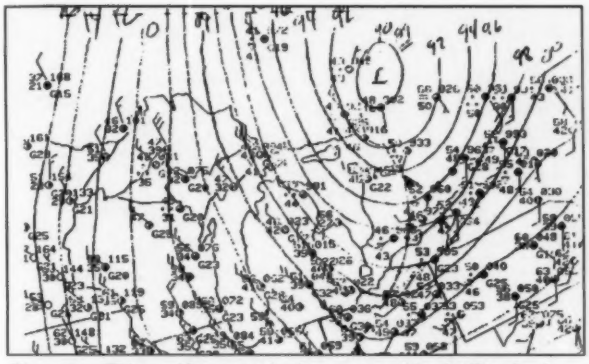


Figure 2.— This working synoptic chart was used by the Cleveland WSFO to track the 989–mb Low at 2200 on the 10th.

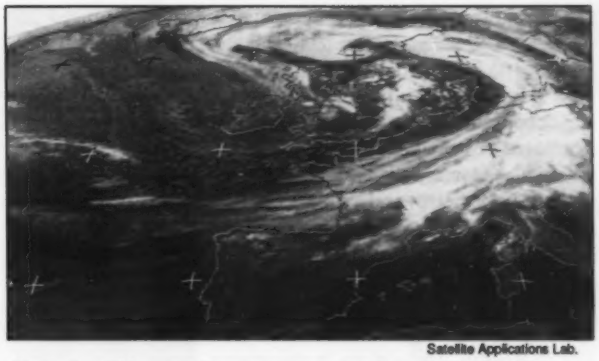


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Figure 3.— This potent Low pressure system is centered between Iceland and the Hebrides at 2100 on the 6th in this IR satellite shot.

east. A warm southerly flow prevailed over the Great Lakes at this time; however west and northwest of the center snow was arriving on strong, cold, north and northwest winds. Pressure falls of 2 to 4 mb were common over Lake Superior and western Lake Michigan. By 2100 on the 27th the 993–mb Low was just west of Thunder Bay, ONT and the largest pressure falls were now over the Upper Peninsula of Michigan. On Lake Superior, Whitefish Pt, MI reported a 36–kn southerly with gusts to 54 kn while the ***Mesabi Miner***, on Lake Michigan, ran into a 43–kn south southwesterly in 13–ft seas. The ***Arthur M. Anderson*** racked up a 38–kn westerly at 0300 on Lake Superior while the ***Frontenac*** on Lake Erie was running into a 40–kn southerly, along with the ***Algo West*** on Lake Huron. The strong winds produced significant storm surge on Lake Erie, which resulted in serious low water situations in the channels of western Lake Erie. At 1200 on the 28th, Trowbridge Lt, ONT reported a northwest wind at 43 kn with gusts to 61 kn while St. Joseph CG, MI reported 12–ft seas. The ***English River***, on Lake Ontario, ran into 44–kn westerlies in 8–ft seas. At 1800 the ***Edgar B. Speer*** on Lake Michigan estimated 10–ft seas in 35–kn winds and Galloo Is., NY registered 38–kn winds. Things calmed down quite a bit on the 29th as the Low swung northward near James Bay.

❸ This storm came to life on the 4th just southwest of Kap Farvel. The system deepened rapidly to 970 mb some 300 mi southwest of Reykjavik,Iceland. Seas over the northern shipping lanes were running 10 to 13 ft. The system turned toward the east southeast and began to fill, slightly. However on the 6th (fig 3) it exploded as central pressure dropped from about 976 mb at 0000 to an estimated 964 mb by 1200. Gales were common south of the center, which was actually defined as two centers on the 1200 chart. By 0000 on the 7th the central pressure had dipped to 955 mb as the center neared the Hebrides. Tiree, Scotland reported gales and the storm's effects were being felt as far south as the Bay of Biscay. The ***Tabasco***, near 44°N, 20°W, encountered 30–kn northwesterlies in 18–ft swells; this was nearly 900 mi southwest of the center. By 0600 the central pressure was estimated at 953 mb and Tiree reported 45–kn winds while gales buffeted the North Sea. However by 1200 the center split once again and began to weaken.

❹ From storm 1 and another Low, which moved over the Labrador Sea, this storm finally evolved on the 14th. By 0000 the following day the center was heading for the Denmark St. The ***00CL Challenge***, some 420 mi to the southwest, reported 30–kn northwesterlies in 15–ft swells, while ***OSV L*** to the east reported 40–kn southerlies in 13–ft swells. Pressure dropped to 990 mb as the Low squeezed into the Denmark St on the 15th. At 0000 on the 16th Galtarviti, Iceland, near the 968–mb center, reported a 50–kn southwest wind with a 974–mb pressure. Once into the Greenland Sea the storm began to fill. However its frontal system continued to produce poor weather from Norway to the British Isles.

Tropical Cyclones— Hurricane Joan came to life during October. For a discussion of Joan, Isaac (September) and the other North Atlantic storms see pg 8.

Casualties— The ***Svea Bay***, with 650 tons of sesame seeds, encountered heavy weather on a voyage from Port Sudan to the Suez. She arrived in the Suez on the 9th with bottom damage. On the 26th the tug ***Alekos*** sustained rudder damage due to high winds at Rafine. The bulk carrier ***Panormos*** anchored in Karmsund, south of Haugesund, Norway, broke wire in stormy weather on the 28th and drifted ashore.

November— The immediately apparent feature on the climatic chart (fig 4) is the Icelandic Low centered northeast of Newfoundland. To the mariner and the climatologist this spells trouble. This is verified by the anomaly chart which shows the average pressure to be 11 mb lower than normal in this area. A quick check of the storm track for the month indicates a concentration of activity between Nova Scotia and Iceland. It also shows a hole over the Norwegian and North Seas and even the Bay of Biscay. The activity in this region has been replaced by a large high over Europe that extends west of the British Isles. A +11 mb anomaly is centered over England. Over the subtropics the Azores–Bermuda High is slightly stronger than normal. In the steering currents at 700 mb, south of 40°N a nearly zonal flow exsisted from the U.S. to about 30°W. North of 40°N a trough pushed southeastward from the Labrador Sea. This U–shaped pattern tended to steer storms sharply north northeastward toward Iceland and the Denmark St. A ridge or inverted U over Spain and the British Isles forms a protective bubble, while enhancing the northeasterly pattern in the eastern North Atlantic.

On This Date—November 14, 1974— a storm dropped 15 inches of snow at Buffalo Airport (New York) and 30 inches on the south shore of Lake Erie.

Extratropical Cyclones— The descriptions of the weather on the Great Lakes are based upon information provided by the WSFO, Cleveland.

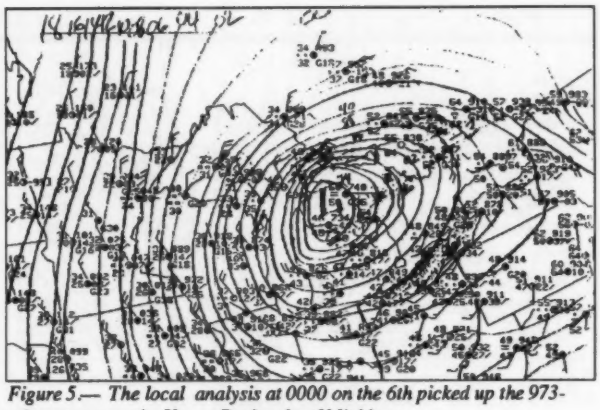

Figure 5.— The local analysis at 0000 on the 6th picked up the 973-mb center over the Upper Peninsula of Michigan.

❶ This storm was double barreled. It caused some problems across the Great Lakes then proceeded to make its contribution to the Icelandic Low. It was first detected on the 3d along the Texan–Oklahoma border. Moving north northeastward it organized slowly. By the 5th it was a large, multi–centered system dominating the weather over much of the eastern U.S. The local analysis at 0000 on the 6th (fig 5) showed a 973–mb center located over the Upper Peninsula of Michigan. A large area of snow was located to the west and southwest, while rain was falling elsewhere. Pressure was falling to the northeast. Between 1900 and 2100 on the 5th, several reports of gale force winds were received. Rock of Ages, MI (Lake Superior) registered a 44–kn blow while the ***Stephen B. Roman*** on Lake Ontario ran into 40–kn east southeasterlies. At 0600 on the 6th the ***Burns Harbor*** came in with a 48–kn north northwest wind in 7–ft seas on Lake Michigan. Stannard Rock, MI on Lake Superior was indicating 44–kn winds gusting to 51 kn. At 0700 NOAA Data Buoy 2 (45.30°N, 86.40°W) measured winds from 340° at 33 kn gusting to 41 kn in 12–ft seas. The central pressure had dropped to 969 mb at 0600, near Little Traverse Bay on northern Lake Michigan. At 1200 the ***H.M. Griffith***, near Long Pt. ONT, hit a 37–kn southwesterly in 5–ft seas. The storm continued northeastward and at 1800 the ***Medusa Challenger*** was belted by 44–kn southwesterlies, on Lake Erie. Actually the local analysis showed the center displaced toward the southeast, so by 0600 on the 7th it was near London, ONT, and weakening. The storm headed just east of James Bay later in the day and by the 8th its was off the coast of Labrador. The central pressure was at 995 mb by 1200.

However, it deepened significantly as it headed for the Denmark St. It gobbled up a storm to the north and its pressure plummeted to 968 mb, by 1200 on the 9th. Some 24 hr later it was down to 952 mb and gales were raking the shipping lanes. Swells of 20–ft were being reported.

On the 9th the storm had made a sharp turn toward the east and the following day it headed east northeastward across Iceland. This was a large and dangerous

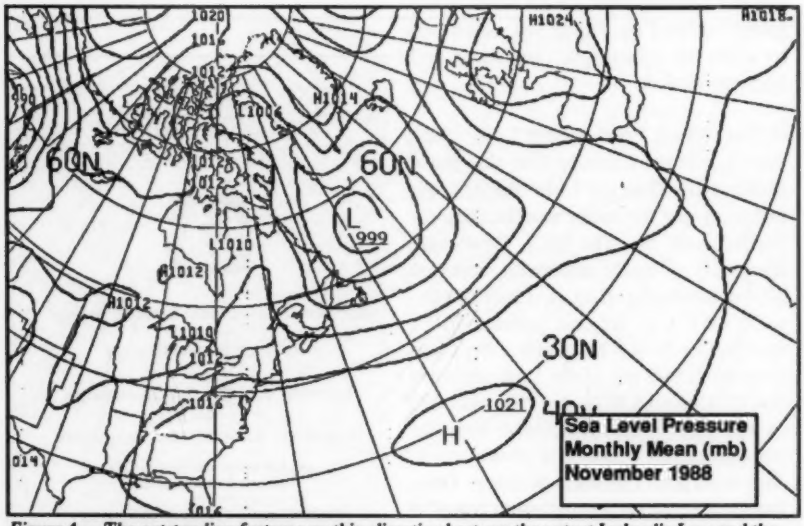

Figure 4.— The outstanding features on this climatic chart are the potent Icelandic Low and the protective high over Europe that extended over the eastern North Atlantic, making for relatively pleasant weather in the east at least.

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Figure 6.— At 0601 on the 26th this enhanced satellite view picks up ex Hurricane Keith at about the time its central pressure dropped to 950 mb. The storm was also turning a counterclockwise loop east of Newfoundland. Its extratropical punch spelled big trouble for shipping.

system. At 1200 on the 9th a vessel near 45°N, 36°W was estimating swell at 26 ft, while the next day a ship near 53°N, 35°W reported 35–kn winds in 20–ft swells. At 0600 on the 11th the DYDA (49°N, 41°W) reported 45–kn westerlies in 20–ft seas. Conditions appeared to be worst to the southwest of the now multiple centers. The circulation remained strong throughout the 11th but began to weaken significantly on the 12th. See the casualty section for the sinking of the ***Odyssey***.

❷ This Great Lakes storm came to life in the eastern North Pacific, some 450 mi west of Vancouver Is on the 13th. It moved into Northern California the following day and by the 15th, at 1200, was a 990–mb storm over the Oklahoma Panhandle. It swung northeastward and by the 16th, the lakes began to feel the effects. Stannard Rock, MI (Lake Superior) at 0900 reported southeast 37–kn winds while the ***American Republic*** sailing Lake Michigan encountered a 40–kn southerly. On Lake Erie at 1200 South Bass Island sent in a report of a 34–kn southerly with gusts to 40 kn. By this time the 974–mb center was near Thunder Bay on Lake Superior. Gales were being reported by such stations as Grand Marais MI, Sheboygan CG, WI, St. Joseph CG, MI, Point Petre, ONT and the NOAA Data Buoy 3 on Lake Huron. The ***Benson Ford*** (46.8°N, 85.1°W) at 1800 ran into a 50–kn southerly in 7– ft seas. Gales continued as the system headed for James Bay on the 17th. At 0000 on the 17th, the ***American Republic*** reported a 50–kn southwesterly at the northern entrance to Green Bay. The storm retained its identity for a few more days. On the 17th it moved across Hudson Bay. The following day it crossed the Hudson St. and headed into the Foxe Basin. By the 20th it moved north of 75°N. The storm ended up on the 21st over northern Ellesmere Is.

❸ This storm began over central Texas on the 19th. After a short trek eastward it turned toward the northeast. On the 21st it moved across Nova Scotia and toward the Grand Banks. The next day the central pressure dropped to 970 mb and the storm attracted the mariner's attention. At 0600 the ***American Resolute*** and the ***Rainbow Hope*** both checked in with 50–kn winds in 30–ft swells south and southwest of the center. The ***Irving Canada*** near 41°N, 66°W measured a 59–kn northwest wind in 39–ft seas. This was confirmed at 1200 by the ***Kenneth E. Hill***, which had measured 59–kn winds and a 988–mb pressure in 36–ft seas. On the 22d and 23d the vessels from 40° and 45°N between 40° and 65°W were under siege from winds in the 45 to 60 kn range with swells of 30 to 40 ft. Reports were received by the ***Barber Nara*** and the ***Lyra***. Then on the 25th at 0300 the ***Queen Elizabeth 2*** (51.3°N, 27.2°W) radioed a 45–kn wind while battling 30–ft swells. (See casualties for more on the QE 2). While this storm was fading fast, ex tropical storm Keith was taking over.

❶ **Monster of the Month**— Keith turned extratropical on the 24th shortly before crossing the 60th meridian. However this was just the first day of the rest of its life. Instead of fading away Keith deepened to 964 mb by 1200 on the 25th. Just ask the crew of the ***Lyra***, which had just finished a battle with the previous storm, only to find itself in 38–ft swells and 50–kn winds near 38.2°N, 48.9°W. At 1800 the ***Star Erviva*** in 50–kn winds was nailed by 30–ft seas some 150 mi southeast of the center. On the 26th the ***Rainbow Hope*** joined the fray. She sent in reports throughout the day, but the worst was at 1200 when she battled 65–kn south southwesterlies in swells estimated at 60 ft; her pressure was 968 mb. The storm's central pressure had bottomed out at about 950 mb around 0600 (fig 6). It was also turning a counterclockwise loop before tracking east northeastward. By 1800 the ***Rainbow Hope*** was still running in 50–ft swells in a 50–kn breeze. On the 27th the monster began to subside slightly. The ***Zienia Olsztynska*** at 0000, some 420 mi southeast of the center, estimated winds at 78 kn from the south southwest. The ***Margit Gorthon*** (49°N, 43°W) reported in with a 52–kn southwesterly; this climbed to 55 kn at 0600 and swells were estimated at 28 ft. By 1200 on the 28th central pressure was 976 mb and climbing. A few days later the system moved across Ireland.

Wide World

Figure 7.— This aerial survey of the bow section of the sinking tanker ***Odyssey*** *was taken from a Canadian Air Force plane on the 10th. There were no signs of the 27 crewmen from the tanker, which had broke in two and burst into flames according to searchers. The* ***Odyssey*** *sent out a distress signal early on the 10th some 100 mi east of Newfoundland. Seas were estimated at 25 ft with 40–kn winds.*

Tropical Cyclones— Tropical storm Keith developed in November in the North Atlantic. Details can be found in the annual summary on pg 8.

Casualties— The ***Queen Elizabeth 2*** was 24 hr late after the worst Atlantic storm her master had experienced. The 66,451–ton passenger ship was battered by force 10 winds and waves were about 50–ft high throughout her 4–day crossing from Boston to Southampton. At times her speed, normally more than 28 kn, was down to 9 kn as she battled the heavy seas. From our reports it looks like she was the victim of storm no. 3 and also the Monster of the Month, as were several other vessels. There was only minor damage but the 1,000 passengers were probably not sunning themselves on the deck. During Keith the ***Percy Navigator***, with a crew of 10, was disabled in the Gulf of Mexico, about 100 mi south of the storm's center. The ***Olympic Star*** from Egypt to Delaware City allegedly sustained heavy weather damage between the 21st and 26th. The ***Othoni*** also ran into heavy weather on the 22d on a voyage from Coryton England to Quebec City.

On the 10th the ***Odyssey***, a British–owned oil tanker split apart and caught fire some 700 mi northeast of St. Johns, Newfoundland. The weather at the time showed heavy seas. While rescuers found two scorched lifeboats there were no signs of the 27 crewmen. "Both lifeboats were empty and both were badly burned", said Canadian Coast Guard spokesman Paul Kendrick. "Survival out there is not good. The water is frigid. In the water with no survival suits on, you would probably perish in a matter of hours at most." It was estimated that seas were about 25 ft with winds of 40 kn. The vessel was totally lost (fig 7) and 133,070 tons of North Sea Crude was dumped into the sea. Rescuers were hampered by the intense heat of the fire on the sea surface.

December— An intense Icelandic Low, centered over southern Greeland, was balanced by an Azores High centered over the Bay of Biscay on this months climatic pressure chart (fig 8). The result was a +14mb anomaly just southwest of the English Channel and a –10 mb anomaly in the Labrador Sea. A look at the track chart shows most of the action between Nova Scotia and Iceland. In the 700–mb steering level, again, the surface features and anomalies are apparent. This resulted in cyclonic curvature from North America to about 30°W turning into an anticyclonic pattern. What this means in an ideal setup, is a storm off New York would move east northeastward then northeastward to about 20° N. It would continue eastward across Scotland then head southeastward across Poland; this looks like a sine wave.

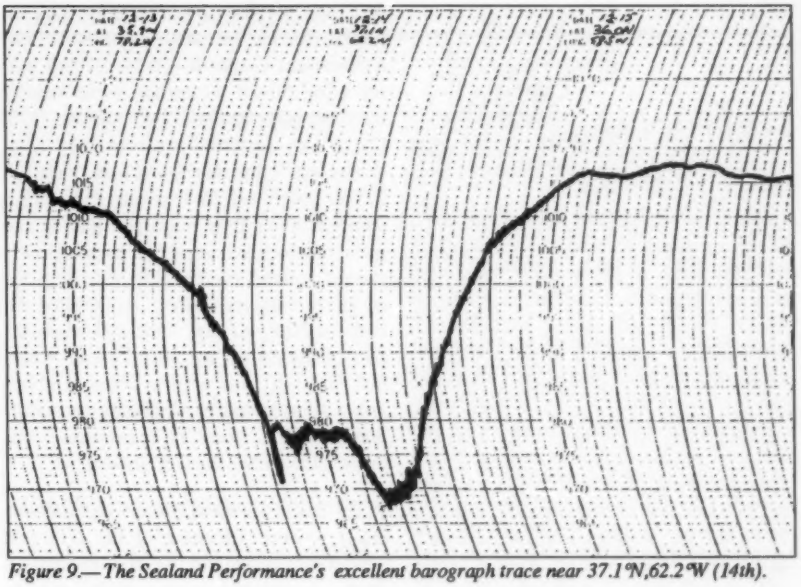


Figure 9.—The Sealand Performance's excellent barograph trace near 37.1°N,62.2°W (14th).

On This Date — December 23, 1811 — A winter storm hit Long Island (NY) with a foot of snow, gale force winds and near 0°–F temperatures. During the storm many ships were wrecked and in some cases entire crews perished.

Extratropical Cyclones— A cold front on the 3d and 4th moved through the Great Lakes region and off the Atlantic coast generating strong gusty winds in its wake. By the morning of the 4th winds were gusting from 35 to 40 kn along the northern Atlantic Seaboard including a gust to 56 kn at Windsor Lock, CT.

On the 8th a Low developed over northeastern Libya. This system moved northeastward and created havoc across the central Mediterranean on the 9th. Newspaper reports indicated that winds on Malta reached 66 kn in some areas. See the casualty section for a summary of the problems to shipping that were created by this system.

On the 15th and 16th a fast moving Great Lakes storm generated winds of 50 to 60 kn across Lake Erie and near gale to gale force winds on the other lakes.

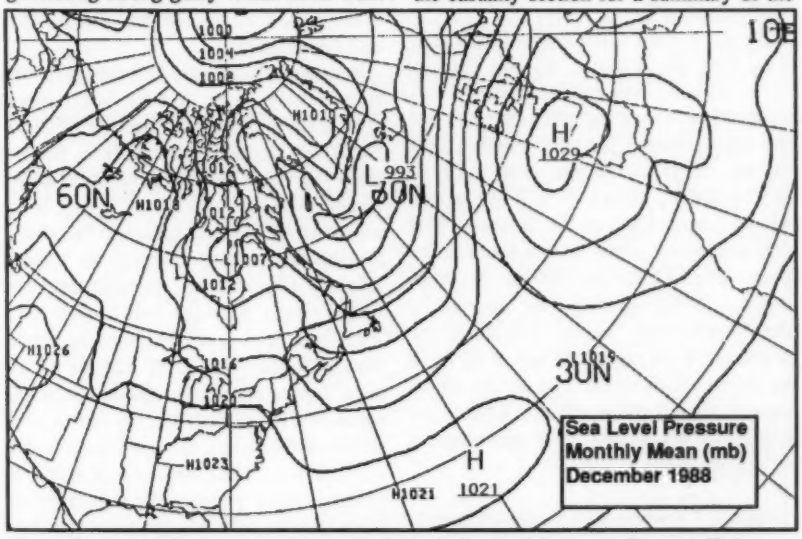


Figure 8.—Both major pressure systems—the Icelandic Low and the Azores–Bermuda High—were more intense than normal in December.

❶ Monster of the Month— This atmospheric wave was discovered along a front off the east coast of Florida on the 13th. It developed rapidly as it scooted northeastward. By 1200 on the 14th the central pressure was down to 962 mb about 350 mi north of Bermuda. The ***Sealand Performance*** from Charleston to Brixham picked up on an excellent trace of this pressure dip (fig 9). At 0600 on the 14th the ***Patty*** and ***Clary*** south and southeast of the center ran into 50–kn winds; by 1200 the ***Patty*** was registering 62–kn southwesterlies about 300 mi southeast of the center. The ***Alemania Express***, a little closer, ran into 60–kn westerlies while battling 33–ft swells. An indication of the central pressure was provided by the ***Margaret Lykes*** at 1800. She sailed very close to the center providing a 970–mb reading in heavy rain whipped by 40–kn winds. The ***Ever Gaining***, some 100 mi to the north, was nailed by 60–kn northeasterlies while battling 33–ft seas. This was a potent storm. However that 970–mb reading was an indication that the

storm was weakening somewhat, as it began to swing northward. At 0000 on the 15th most of the wind reports were between 40 and 50 kn, although swells up to 33 ft were still being encountered. Some 300 mi northeast of the center the ***Leonard J. Cowley*** picked up 54–kn easterlies. At 1200, 50–kn winds were encountered by the ***Abbey*** and the ***Vercors***. As the system moved northward it reintensified. By the 16th at 1200, central pressure had dropped to 960 mb near 55°N, 46°W. Reports from vessels such as the ***BP Energy, Falcon, Koln Atlantic*** and ***OSV C*** indicated winds in the 40 to 55–kn range with swells up to 20 ft. At 1800 on the 16th the ***Enterprise*** sent in a telling report some 180 mi south of the center. Her winds were clocked at 65 kn from the west southwest while seas were running at 33–ft and pressure was measured at 964mb; all of this in moderate rain— a great report. Six hr later the ***Enterprise*** had moved out of the heavy stuff but still had 55–kn southwesterlies in 26–ft swells. At 0600 on the 17th the ***Johan Petersen*** (60°N, 41°W) was raked by 68–kn northerlies in 33–ft seas. Meanwhile the storm was moving across Kap Farvel and heading toward Iceland. By 1200 on the 8th pressure rose to 994 mb and things began to quiet down.

❷ Spawned off the coast of southern California on the 16th, this storm slowly worked its way across the southwest over the next 3 days and then accelerated toward the Great Lakes on the 20th. By 1200 it had gained a 989–mb pressure center over western Lake Superior. Ships on Lake Erie reported winds of more than 40 kn. By the 21st the system had filled as it moved across Quebec. At 1200 on the 22d the 1001–mb center was just northeast of Newfoundland. It then began to reintensify and swing toward the northeast. By the 24th central pressure fell to 976 mb and the following day it was at 962 mb. By this time it was making an impression on the shipping lanes. The ***Kosmonant Gagarin*** (56°N, 37°W) was reporting 50–kn westerlies while nearby the ***Skogafoss*** battled 52–kn winds. OSV C in 47–kn westerlies was rocked by 33–ft swells, while the ***Albright Pioneer*** (56°N, 21°W) fought off 26–ft swells. The storm recurved toward the north and then began a counterclockwise loop that took it slowly toward Iceland on the 29th. During this period it remained potent. At 0600 on the 26th the ***Nungu Ittuk***, some 200 mi southeast of the center, hit 60–kn southwesterlies in 33–ft seas with a slope of about 1/20. This compares favorably to conditions at ***OSV C*** were 31–ft seas were estimated also with a slope of about 1/20.

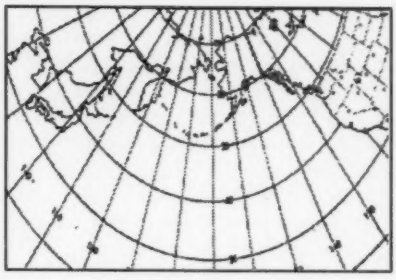
❸ While the previous storm was meandering southwest of Iceland, on the 27th, this system was coming to life in south–central Texas. By the 28th it was moving rapidly through Pennsylvania, New York and New England and heading out to sea. The cold front associated with this system brought winds from 55 to 65 kn along the Atlantic coast from Baltimore to Boston. The winds were associated with a line of heavy rainshowers. Trees were blown down and some areas lost power. A roof was blown off a house in Newark, DE. To the east of the front, temperatures rose to 60°F as far north as Boston and 70°F as far north as Washington, DC.

The storm itself really began to intensify once into the Atlantic. By the 29th, at 1200, pressure was estimated at 970 mb. Some 24 hr later it had plummeted to 946 mb after crossing the 55th parallel near 50°W. At 0700 on the 30th ***OSV C*** (53°N, 36°W) recorded 979 mb with a 41–kn south wind in 21–ft seas. The ***Ocean Prawns***, some 300 mi south of the center at 1200, ran into 52–kn westerlies while a 50–kn westerly was reported by the ***Ravenscraig*** nearly 500 mi to the southeast of the center. Winds of 40 to 50 kn continued into the 31st as the storm moved toward the northeast. The ***Aries*** (47°N, 43°W) battling 26–ft seas reported 47–kn westerlies at 1800.

Tropical Cyclones— No tropical storms or hurricanes developed this December. Since 1931 only four tropical cyclones have come to life during December; two of these reached hurricane intensity.

Casualties— On the 5th the British–flag dredger ***Bowsprite*** broke into and sank in heavy seas 14 mi north of Nieuwpoort, Belgium. Four of the ten crewmen were rescued by a Belgian helicopter. The ***HMS Upton*** rescued two others and recovered two bodies. Two were listed as missing. A storm in the central Mediterranean caused havoc to shipping on the 9th. The worst incident involved the ***Four Star I*** in the southern Ionian Sea on the 9th. The vessel took a sudden and heavy list to starboard and sank a short time later, south of Malta. Ten of the thirteen crewmen were able to get aboard a life boat and were rescued by the ***Burgasi***. The Greek Master, chief engineer and a seaman were missing. The ro–ro ***El Carrier's*** cargo shifted in heavy seas and she developed a 28° list. She was abandoned after the list increased to 40°. The ***Kaptan Ismail*** ran into heavy weather 13 mi from Cape Passero, Sicily and developed a 10° list. The Ro–ro ***Ghat*** arrived Tripoli with a 29° starboard list, made it to a berth and sank. Mayday calls were received from the ***Mandingo***, ILGL, ***Bianca Maria***, ***Marco Tuglis***, and ***Francesco 2***. Vessels that suffered damage or were grounded included the ***Angeliki, Iran Amanat, Rikia, Copper Mountain, City of Athens, Red Merlin,*** and ***Thancssakis***.

Rescue workers saved 27 crewmen who spent nearly 24 hr in a survival capsule after their drilling platform, the ***Rowan Gorilla I*** , capsized more than 500 mi from the Canadian coast. The platform turned over on the 15th as it was being towed from Haifax to Great Yarmouth, forcing the crew to abandon the rig and await rescue in the survival capsule. Initial rescue attempts were thwarted by gales and 40–ft seas. The rig sank on the 19th. On the 28th, some 220 mi off the New Jersey coast, the ***Lloyd Bermuda*** reported a cargo shift and the vessel sank. Seven of the eleven crewmen were reported missing. The ***Maloja II*** suffered alleged heavy weather damage from the 15th to 17th on a voyage from Hamburg and LeHarve for Montreal.



North Pacific Weather Log October, November and December 1988

The Weather Logs, cyclone tracks, buoy, gales and wave tables and mean pressure charts provide a definitive report on the primary storms that affect the North Atlantic and North Pacific Oceans. The Monster of the Month is a title given to an extratropical storm that has been particularly hazardous to shipping. All storms can be dangerous. The tropical cyclones summaries are based on reports from, the National Hurricane Center, Royal Observatory at Hong Kong and the Joint Typhoon Warning Center at Guam. They are detailed but should be considered preliminary until the final reports are issued. Unless otherwise stated, winds are sustained and time is Universal (UTC). The number next to the extratropical summary corresponds to the same number on the track chart.

October— Usually the 1000–mb Aleutian Low is centered in the Gulf of Alaska and its circulation covers the seas north of 40°N. This month (fig 1) it was weaker than normal. A ridge of high pressure over Alaska and eastern Siberia resulted in positive anomalies of up to 5 mb in the Bering Sea and off southeast Alaska as well as a +9 mb anomaly along the North Slope. The Aleutian Low forced west of its normal position created a large area of negative anomalies over the northwest North Pacific including the Sea of Okhotsk. The 700–mb steering level was fairly zonal from west to east out to 150°W where a cyclonic curvature was noticeable. This would take a storm from Tokyo to Vancouver Is.

On This Date— October 12, 1962— The Great Columbus Day windstorm was probably the most damaging storm of record west of the Cascade Mountains in the Pacific Northwest (U.S.). Winds reached hurricane force, with gusts above 85 kn. More than 3.5 billion board feet of timber were blown down and communications were severely disrupted. The storm claimed 48 lives and caused $210 million in damage.

Extratropical Cyclones— Despite the positive anomalies off southeast Alaska there was plenty of action in the Gulf of Alaska. Also, along and just south of the Aleutian Is storms kept ships alert throughout the month. Over the northern Bering Sea and in the Beaufort and East Siberian Seas activity was light.

❶ Ex Super Typhoon Nelson created a few problems in its extratropical stages. It retained typhoon force winds into the 9th. However by 1200 central pressure was estimated at 996 mb. To the south though, swells were running 15 ft according to the *Sealand Voyager*. Then on the 10th the system reintensified and pressure dropped to 968 mb by 1200. To the east of the center swells of 16 to 26 ft were being reported. The *Hyuaga Mara* was one of the reporting vessels. The *President Garfield* hit 15–ft swells at 0600, on the 11th, some 420 mi southeast of the storm's center. Central pressure by this time had risen to 970 mb and the storm was heading eastward. It continued to fill.

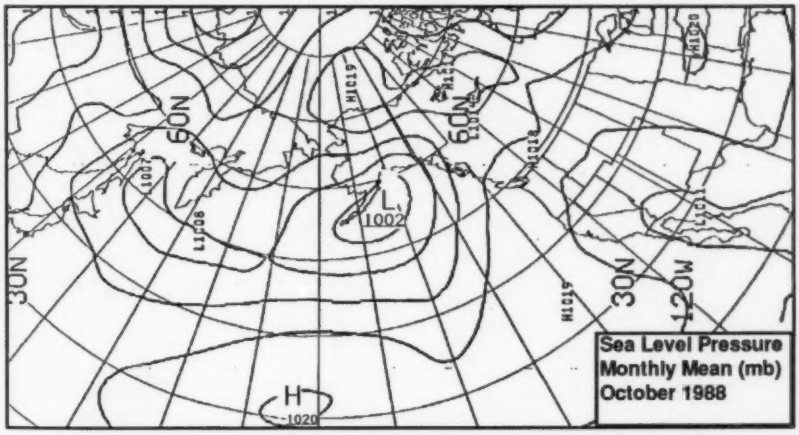


Figure 1.— This was a month of displaced climatic features. The Aleutian Low was forced west of its normal position by strong ridge of high pressure.

❷ On the 11th this system was detected as an atmospheric wave along a front just west of the Sakhalin Peninsula. It wasn't much to look at on the 12th. But in the life of a storm, what a difference a day makes. By 0000 on the 13th it was combining with another wimpy wave and a large, dangerous circulation was becoming evident. Along the front to the south gales were being reported out to 800 mi. A vessel near 44°N, 156°E encountered a 20–ft swell in 35–kn southerlies at 0600.

By 1200 the central pressure had dipped to 968 mb and the pressure gradient was very tight to the east of the center. On the 14th a 958–mb center crossed the 55th

parallel near 146°E. The storm had moved toward the northwest for 24 hr. The 14th was a wild day over the northern routes west of 180°, and it continued into the 15th. Swells of 15 to 25 ft were encountered to the south and east of the center. Gales were reported more than 700 mi to the south. Finally on the 15th the system began to weaken by about 1200. However the front continued to create problems. At 0000 on the 16th the ***Aqua City*** (52°N, 165°E) ran into 21–ft swells just west of the cold front. However by late in the day conditions began to calm down.

❸ This Gulf of Alaska storm was first detected on the 17th as an atmospheric wave along the front of the previous storm. It was actually one of a series of waves but the only one that amounted to anything. First spotted near 37°N, 147°E it moved on a familiar east northeast track. On the 19th it turned northeastward and began to organize. By 1200 on the 20th, the 986–mb Low was approaching the 50th parallel near 176°E. Several ships were reporting 30–kn winds. By 0000 on the 21st a vessel, some 540 mi west southwest of the center, picked up a 40–kn northwesterly. The central pressure dipped to 968 mb as the storm reached the Aleutians at 1200. Adak was belted by 30–kn northwesterlies as the storm moved toward the Gulf of Alaska. Even though the pressure rose to 981 mb by 1200 on the 22d, the system was dominating the weather over the northeast North Pacific. The ***Rainbow Ace***, about 300 mi south of the center, encountered 35–kn winds in 23–ft seas while the MTES some 480 mi to the southeast ran into 13–ft swells in 30–kn winds. The 985–mb storm moved through the Gulf of Alaska and over land near Cordova on the 23d. It turned back toward the west, slowed and dissipated.

❹ **Monster of the Month**— This story is a two–parter and a mystery as well. The first part will be told now and the rest of the story can be found as the first storm in November. The mystery occurs in the first part. On the 29th a weak frontal wave had organized into a 983–mb Low at 1200 near 42°N, 152°E: nothing unusual in this. However 24 hr later the system had moved slightly northward and exploded. The central pressure plummeted to an estimated 959 mb. There were several ships in the vicinity of the center but unfortunately most of the reports were missing. One did indicate a 964.1–mb pressure while another some 300 mi to the northeast reported a 975–mb reading. So this tends to verify the central pressure. Another ship near 39°N, 145°E encountered 45–kn northwesterlies while battling 16–ft swells.

There is nothing too mysterious about a storm deepening 24 mb in 24 hr— it's called rapid. However by 0000 on the 31st the pressure was up to 974 mb. This rapid drop and rapid rise are not often seen. This rise did not create a significant improvement in conditions however. To to the northwest, along the Kurils, winds of 40 to 45 kn were common. To the south and southwest vessels reported 50–kn plus winds. The KRGT, some 300 mi to the south hit 34–ft swells. This was confirmed by the ***Neptune Emerald*** even farther south; she ran into 30–ft swells while fighting 50–kn westerlies. So this was truly a powerful storm. By 1200 three different centers were identified and the system seem to be breaking up. Check the first November storm for the exciting conclusion. Was the monster really finished?

Tropical Cyclones— The North Pacific Ocean was the scene of five significant tropical cyclones in October. Four typhoons developed in the west while Atlantic Hurricane Joan was transfigured into eastern North Pacific Hurricane Miriam simply by crossing Nicaragua and surviving. The western North Pacific summaries are based on information from the Joint Typhoon Warning Center supplemented by data from the Hong Kong Royal Observatory.

Nelson (fig 2) was the only storm of

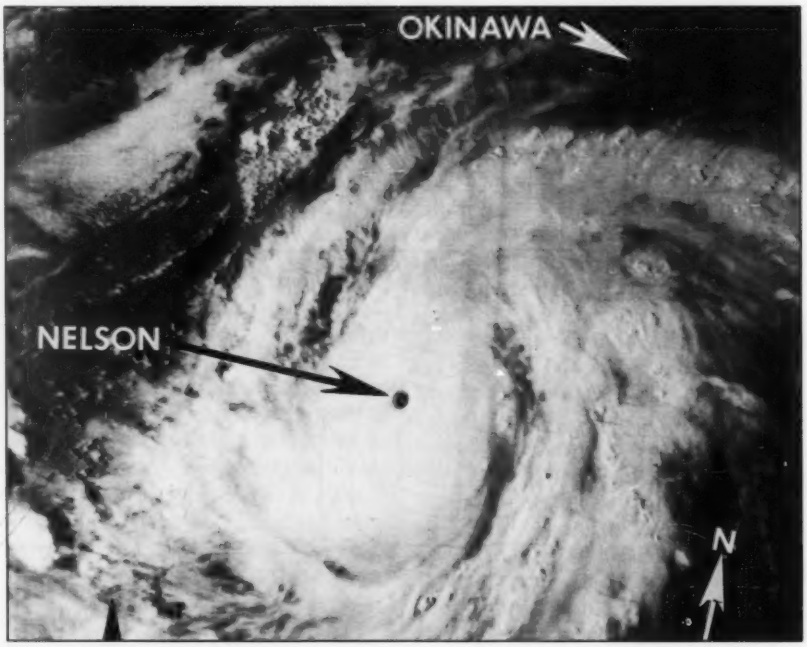


Figure 2.— Super Typhoon Nelson, near peak intensity, displays a well defined 20–mi diameter eye. This photo was taken at 0709 on the 4th.

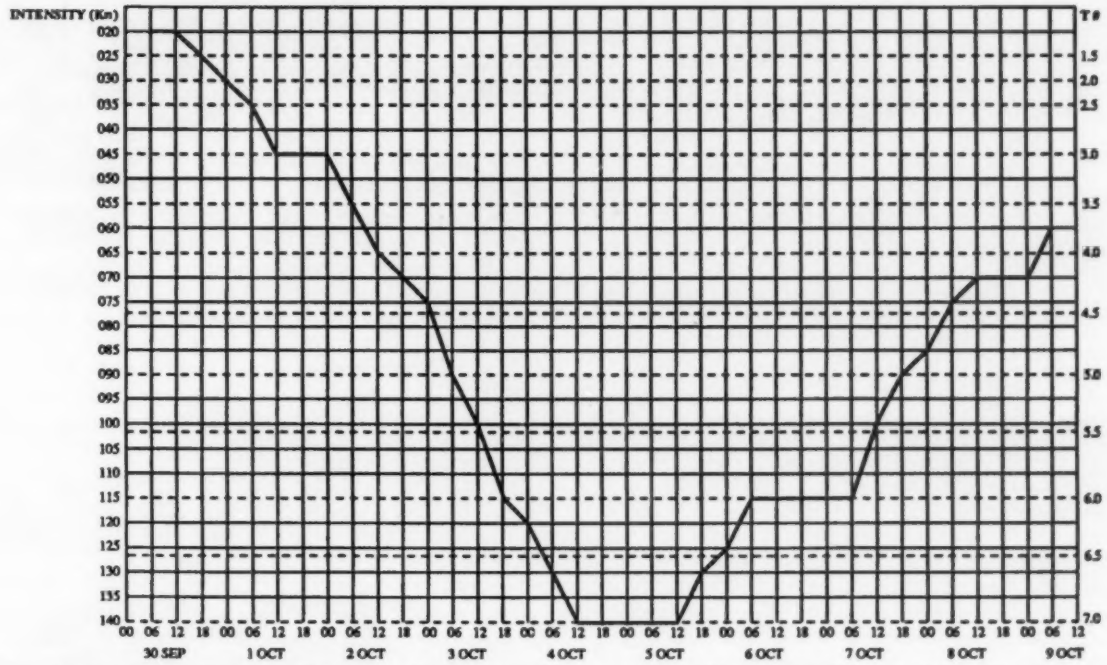


Figure 3.— An analysis of intensity with time shows Super Typhoon Nelson's rapid intensification from 0000 on the 2d to 1200 on the 4th of October. Note the peak intensity of 140 kn persisted from 1200 on the 4th until 1200 on the 5th. Chart furnished by the Joint Typhoon Warning Center, Guam.

1988 to reach super typhoon intensity (winds of 130 kn or more). Nelson was first discovered as a disturbance 200 mi southwest of Guam in late September. Tropical storm intensity was attained at about 0600 on the 1st of October. Some 30 hr later maximum winds were estimated at 65 kn as the system moved along the periphery of the subtropical ridge. Nelson continued to intensify and reached super typhoon strength at 0600 on the 4th (fig 3). Near gale force winds were reported over the Taiwan St as Nelson remained well to the east. Kadena Air Base on Okinawa reported sustained winds of 38 kn with a peak gust of 59 kn. Nelson weakened as it moved into the Pacific. It turned extratropical and its remnants became storm no 1.

As Nelson was turning extratropical, **Odessa** began some 460 mi south southeast of Minami Tori–shima. The system reached tropical storm strength on the 11th at 1200. By the 13th just after 1100 winds in the slowly recurving storm were estimated at 65 kn. The midget typhoon peaked at 1200 on the 14th when winds hit 90 kn. The following day, an extratropical transition was underway.

From the 16th to the 18th **Pat** developed over the warm Philippine Sea. By the 18th the convection had organized. Finally Pat became a tropical storm early on the 19th and assumed a westward course. The storm maintained typhoon intensity into the South China Sea. The ***Sealand Mariner***, some 120 mi northeast of the center at 1800 on the 21st, reported 998 mb with an east wind of 50 kn. Typhoon Pat made landfall over southeastern Hainan Is around 1200 on the 22d. It weakened to a tropical storm early the next day and finally dissipated near Hanoi the same morning.

Ruby became the fifth tropical cyclone to hit the Philippines in 1988. If formed in the Philippine Sea on the 20th, assumed the track of a straight runner and intensified. At 1200 on the 24th as it neared land Ruby reached a peak intensify of 125 kn. Like most storms that track over the Philippines, Ruby weakened as it moved across Luzon. At Cantanduanes, just off eastern Luzon, a pressure of 946 mb with winds of 66 kn were recorded at 0600. Ruby entered the South China Sea early on the 25th. Peak gusts following Ruby's departure reached 69 kn at Subia Bay and 46 kn at Clark Air Base. Ruby moved towards Hainan. Interaction with the mountainous terrain of Hainan caused the tropical cyclone to weaken. Ruby was a devastating storm, particularly in the Philippines (fig 4). It has been estimated that more than 300 people were killed including over 150 who drowned when the ***Dona Marilyn*** capsized. Over 470,000 people were left homeless. Damage to crops was estimated at $45.7 million. Ruby in combination with the northeast monsoon brought prolonged, heavy rains to eastern Taiwan. On Hainan, according to press reports, one person was killed and fifteen injured. Press reports also indicated that Typhoons Pat and Ruby had left at least 90 people dead in Vietnam.

Casualties— During Typhoon Ruby, in addition to the ***Dona Marilyn*** tragedy, the

Figure 4.—This is an aerial view of a town on the country's main island of Luzon, north of Manila, which was inundated by rain–producing floods from Typhoon Ruby. Most low–lying areas remained underwater for several days.

ferry ***Zenaida***, with 20 people on board was reported missing off Quezon Province. The freighter ***Jet Ann Five*** sank near Bohol Is in the southern Philippines. Vessels that grounded or were damaged include the ***Helen Raqual, O.K. Uno, Dona Corazon II, Sea Sprite, Nordwind, Peterson Lu*** and the ***Balaki***. The ***Tunsoy*** grounded after drifting from anchorage in Limay, Bataan to the Bulacan shore. The Master was rescued by the Philippine Air Force but three others were missing.

On the 14th a domestic ferry boat capsized in stormy waters off Aurora Province northeast of Manila. The ***Lady Aurora*** was overturned by strong winds and huge waves. Some 22 bodies were recovered. In addition the 34–ton ferry ***Palangiza*** capsized in the Leyte Gulf, 400 mi south of Manila, also on the 14th. Dozens of passengers, coming home from a fiesta, were trapped inside. An estimated 51 people died and 78 were rescued.

November— Like the Atlantic's Icelandic Low, the Aleutian Low stood out like a sore thumb in the Gulf of Alaska this month (fig 5). While it usually dominates most of the northern North Pacific, in November it was concentrated in the northeast, which resulted in negative anomalies up to 14 mb. In addition an Arctic high pushed south over the northern Bering Sea, resulting in positive anomalies and a tight pressure gradient over the Beaufort, Chukchi and East Siberian Seas and in the Bering St. The subtropical high off California was also more intense than normal while off Japan pressures were 4 to 6 mb lower than usual. The steering pattern at 700 mb was oriented in a west southwest–east northeast direction so that a storm from Tokyo might end up over Oregon in an ideal situation.

On This Date— November 18, 1968 — Typhoon Mamie was over the Philippines when the ***Iruna*** in Cebu Harbor was rammed and sank by the ***Eastern Moon***; some 90 lives were lost.

Extratropical Cyclones— A quick glance at the track chart for November shows a traffic jam in the Gulf of Alaska.

❶ The saga of the late October storm continues. When we left it three centers seemed to indicate curtains. However they all merged and by 1200 on the 1st a 962–mb center was located near 50°N, 165°W. Gales were being reported some 600 mi to the south where swells from 13 to 25 ft were being encountered. The ***President Tyler*** ran into a 60–kn blow at 0000 on the 2d as the 966–mb storm headed east southeastward. It began to weaken but proved pesky into the 3d when it became engulfed by another system to the east.

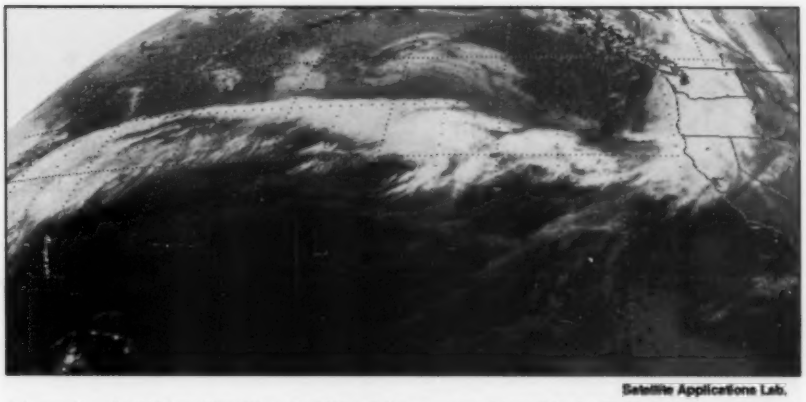


Figure 6.— At 1546 on Nov 21st, the 954–mb Low was positioned in the Gulf of Alaska. More interesting however, is its leading cold front over the Pacific Northwest, which trails into the second system whose front extends across the Pacific.

❷ While the previous storm was finally giving up the ghost this system appeared off the Kamchatka Peninsula, on the 3d. It deepened rapidly as it moved east northeastward into the Bering Sea. By 1200 on the 4th the central pressure was down to 960 mb. The ***President Truman*** (52°N, 161°E), at 1600, ran into 60–kn measured winds from the west southwest in 23–ft seas and 26–ft swells; her pressure was 987 mb. The ***Raven Arrow*** confirmed this with a 55–kn reading in 30–ft swells. At 0000 on the 5th the ***Hanei Pearl*** (51°N, 163°E) was surviving 41–ft swells while able to measure 48–kn westerlies. In general swells of 30 to 40 ft were being reported out to about 450 mi south of the center. The ***Raven Arrow*** posted several helpful reports on the 5th as well. By this time the system was beginning to fill and had turned eastward. On the following two days it recurved over the Alaska Peninsula and headed back into the Bering Sea.

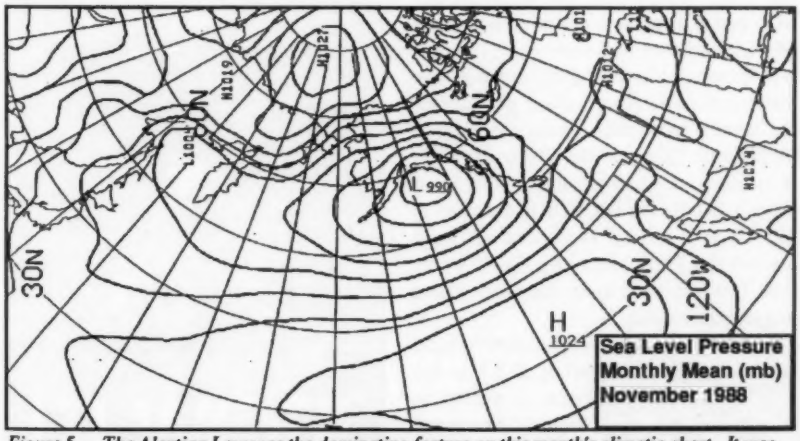


Figure 5.— The Aleutian Low was the dominating feature on this month's climatic chart. It was forced over the Gulf of Alaska by an Arctic high. In reality the high pushed storm tracks toward the Gulf and they make up the Aleutian Low.

❸ This is a tale of two storms. They ended up in the Gulf of Alaska as one blockbuster. The first one was picked up on the track chart on the 16th northeast of Tokyo and intensified slowly. The second storm popped up 2 days later about 180 mi southwest of the first one. It ran a parallel course but remained 2 days behind. By the 20th the first system was dominating the northeastern North Pacific with a 956–mb pressure center (fig 6). The second system moved in from the southwest by the 21st. Pressure was down to 954 mb in the first system. On the 22d the two had merged circulations if not centers. At 1800 the ***Dubhe*** (52°N,137°W) was racked by 60–kn northwesterlies. The ***Presence*** (55°N, 154°W) hit 30–ft swells in 45–kn winds, while the ***Yuzuru Maru***

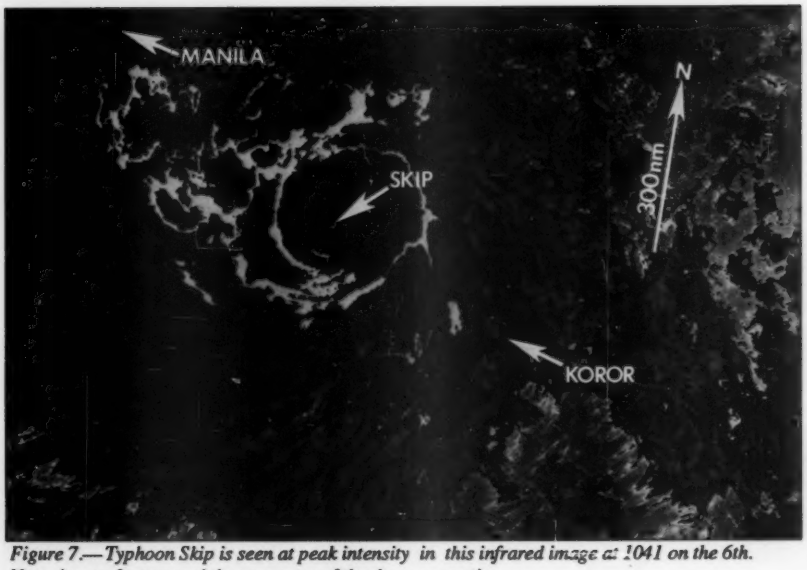


Figure 7.—Typhoon Skip is seen at peak intensity in this infrared image at 1041 on the 6th. Note the eye feature and the symmetry of the deep convection.

measured 50–kn westerlies in 35–ft swells some 300 mi southwest of the center. Then at 2000 on the 22d the ***Exxon Long Beach*** (51°N, 135°W) while fighting 30–ft swells measured a 70–kn west northwesterly and a 968–mb pressure. An hour later the ***Westward Venture*** (59°N, 150°W) came in with a 57–kn blow in 33–ft swells. The seas were boiling. On the 23d measured winds ranged from 45 to 60 kn while swells built up from 26 to 41 ft. Ships reporting in under trying conditions included ***Sea Bells, Great Land Sansinena II*** and the ***Yuzuru Maru.*** Even though the system was weakening storm conditions were reported into the 24th.

❶ While the previous system was dissipating, another Gulf of Alaska storm was brewing, on the 25th, near 45°N, 165°W. It made its impact on the 27th. By 1100 the ***Mobil Meridian***, battling 33–ft swells near 54°N, 135°W, called in 56–kn south southwesterlies; her pressure was 971mb. The storm's central pressure was down to 952 mb. Two other tankers, the ***Mobil Arctic*** and the ***Arco California*** kept forecasters apprised of conditions throughout the day. The ***Arco California*** reported a measured 60–kn southerly at 1800 while on two reports the ***Mobil Arctic*** was fighting phenomenal 60–ft swells. Seas were running 20 to 30 ft during the day as these vessels sailed east of Vancouver Is. Conditions improved on the 28th.

Tropical Cyclones— The western North Pacific spawned two November tropical cyclones— Typhoons Skip and Tess.

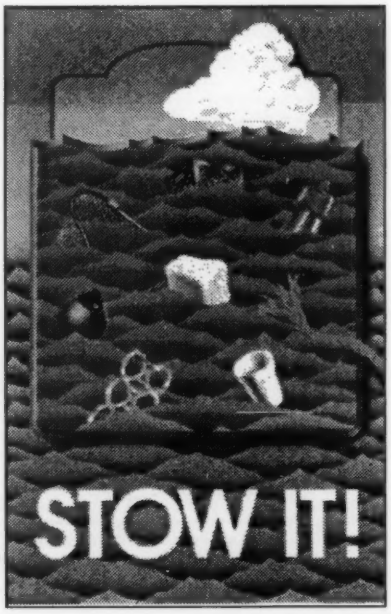
On the 1st of November the northeast monsoon was well established across the South China Sea and Southeast Asia. A disturbance that was to become Typhoon Tess was bringing more rain and wind to the central Philippines. The following day Skip began as an area of convection some 360 mi southwest of Guam.

Meanwhile Tess as a disturbance was tracking southwestward along the edge of the winter monsoon, across the rugged Philippines. Skip was the first to organize to tropical storm intensity on the 3d at about 1800. By the 6th, Skip had peaked at 125 kn as it moved west northwestward toward the Philippines (fig 7). By this time Tess had made it into the South China Sea and intensified.

At 0600 on the 4th Tess reached tropical storm strength and peaked at 65 kn by 1200 on the 5th. Tess began to weaken as it approached the coast of southern Vietnam. Skip, meanwhile, was heading for the Philippines and it also began to weaken. The typhoon accelerated to a forward speed of 21 kn as it tracked across the island of Mindoro on the 7th. At least 104 people were killed by mudslides, floods and flying debris and another 95 were listed as missing. Numerous ships and boats were missing or had run aground.

After weakening over the Philippines, Skip slowed down as it entered the South China Sea. During the next 4 days, Skip pushed west northwestward. By 0600 on the 10th it was downgraded to a tropical storm. The remnants of Skip drifted into the Gulf of Tonkin and dissipated.

Casualties— The ***Harmac Dawn*** from Tacoma, WA to Japan experienced heavy weather off the Washington coast, early in the month; a cargo of lumber had to be repacked. In Typhoon Skip the ***Sea Runner*** sank with 11,500 bags of cement off Bohol Is; all 17 crewmen were rescued. Also the ***Ethane*** ran aground off Tres Reyes Is, 110 mi south of Manila while the passenger vessel ***Sampaguita*** ran aground near Zamboanga. No loss of life was reported in either incident.



December— The indicator of Pacific storm activity the Aleutian Low, was displaced westward from its normal position. One of the centers is usually over the Gulf of Alaska but this December it was in the northern Bering Sea (fig 8). This resulted in a –6 mb anomaly south of the Bering St. In addition, and in part responsible for the shift, the subtropical high was more intense and northwest of its usual position. This caused positive anomalies up to 10 mb centered near 45°N, 140°W. These same features were reflected at the 700–mb steering level. This created a nearly zonal flow west of the International Dateline curving cyclonically northeastward to the east. A storm caught in this pattern at Tokyo would end up over Vancouver Is.

On This Date— December 1832— The first record of a tropical cyclone in the central North Pacific was found at 13°N, 148°W from the log of a German merchant vessel. From the first point of record it was tracked west northwestward to a point 350 mi south of South Point on the Big Island and then to just south of Johnston Is.

Extratropical Cyclones— A series of storms not potent enough at sea to be described in the summary, brought severe weather to the U.S. West Coast late in the month. On the 20th a 980–mb Low moved toward the Pacific Northwest spreading heavy rain along the coast and snow inland. High surf pounded the northern California coast. During the last week of the year another system produced 2.70 in of rain at Astoria, OR on the 29th. Gusts of more than 50 kn were measured at Astoria and Seaside. On the 27th snow fell over much of northern California.

❶ This storm had its beginnings in late November. It didn't become potent until the 1st when it merged with another system, near 45°N, 175°E. The storm was moving toward the east southeast but gradually turned northeastward after crossing 165°W. By the 2d at 1200 the 960–mb center was creating problems for ships. The ***Kapitan Markov***, some 350 mi northeast of the storm center, encountered 45–kn northeries in 16–ft seas. By 1800 the ***Shirotae Maru, Neptune Ace, Takami Maru*** and ***Hundai No. 206*** were reporting 40–to 45–kn winds in 12–to 16–ft swells in the storm's northern semicircle. To the southeast of the center the ***Kentucky Highway*** (45°N, 139°W) hit a 55–kn southerly in 16–ft swells. However by the 3d the storm began to weaken and was absorbed into another system.

❷ This storm sprung up just west of Hokkaido late on the 4th. It moved northeastward and then northward while organizing on the 5th and 6th. By 1200 on the 6th, central pressure was down to 976 mb but the storm was heading through the Sea of Okhotsk. However a sudden reversal

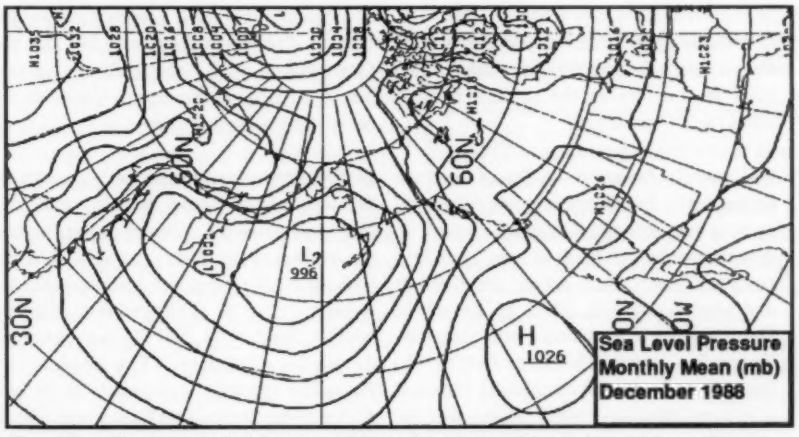
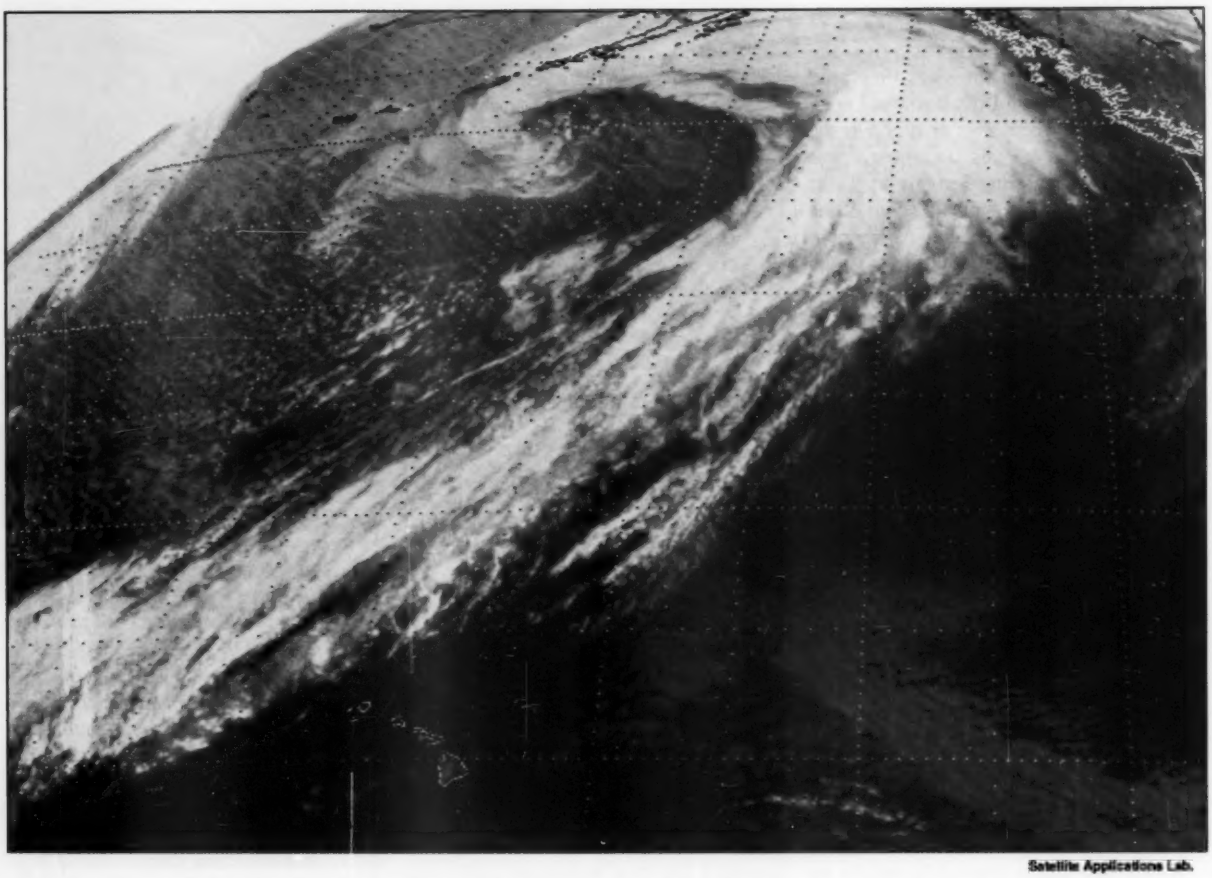


Figure 8.—The subtropical high was northwest of its usual position and more intense than normal, while the Aleutian Low was displaced westward.



Satellite Applications Lab.

Figure 9.— This satellite view of storm no. 2 is very impressive. It was taken at 1216 on the 10th of December. The central pressure by this time had dipped to 966 mb. The well–defined cold front can be seen approaching the Hawaiian Islands.

kept the system intact although weakened. By the 7th it was moving out into the North Pacific and began to redevelop. The following day the storm neared the 40th parallel but on the 9th it swung toward the northeast. Also central pressure was down to 972 mb by 1200. Twenty four hr later it dipped to 966 mb (Fig. 9). The ***Sumatra*** (54°N, 177°W) ran into 44–kn north northeasterlies at 1200 and 1800. In general winds were running from 40 to 50 kn while a few vessels such as the ***Yashirokawa Maru*** (55°N, 143°W) encountered 16–ft swells. By 0000 on the 11th storm force winds were being reported by the ***George Washington Bridge, Ace Accord, Nosac Express, Luzon*** and ***Kasina***. Both the ***Kasina*** and ***George Washington Bridge*** were fighting winds of more than 60 kn. The ***Kasin*** was also battling 39–ft swells and 25–ft seas with a slope of 1/50. The ship really hit the fan. That seemed to be the peak as things began to quiet down later in the day as the system headed inland near Anchorage.

❻ This baby began in the Sea of Okhotsk on the 16th. It was actually one of several centers but managed to grab control on that date. So by 1200 it was already a potent 968–mb storm raking the Kuril Is and nearby seas with 20–to 35–kn winds. Once across Kamchatka and into the Bering Sea, it intensified even further. On the 17th and 18th the circulation enclosed a 962–mb pressure center. Ships over the northern routes were being pounded by 45–to 60–kn winds, particularly between 1200 on the 17th and 1200 on the 18th. Some of the reporting vessels included the ***Gissar, Professor Kaganovskiy*** and the ***Osprey Arrow***. By the 19th the system began to slow down and weaken in the north–central Bering Sea.

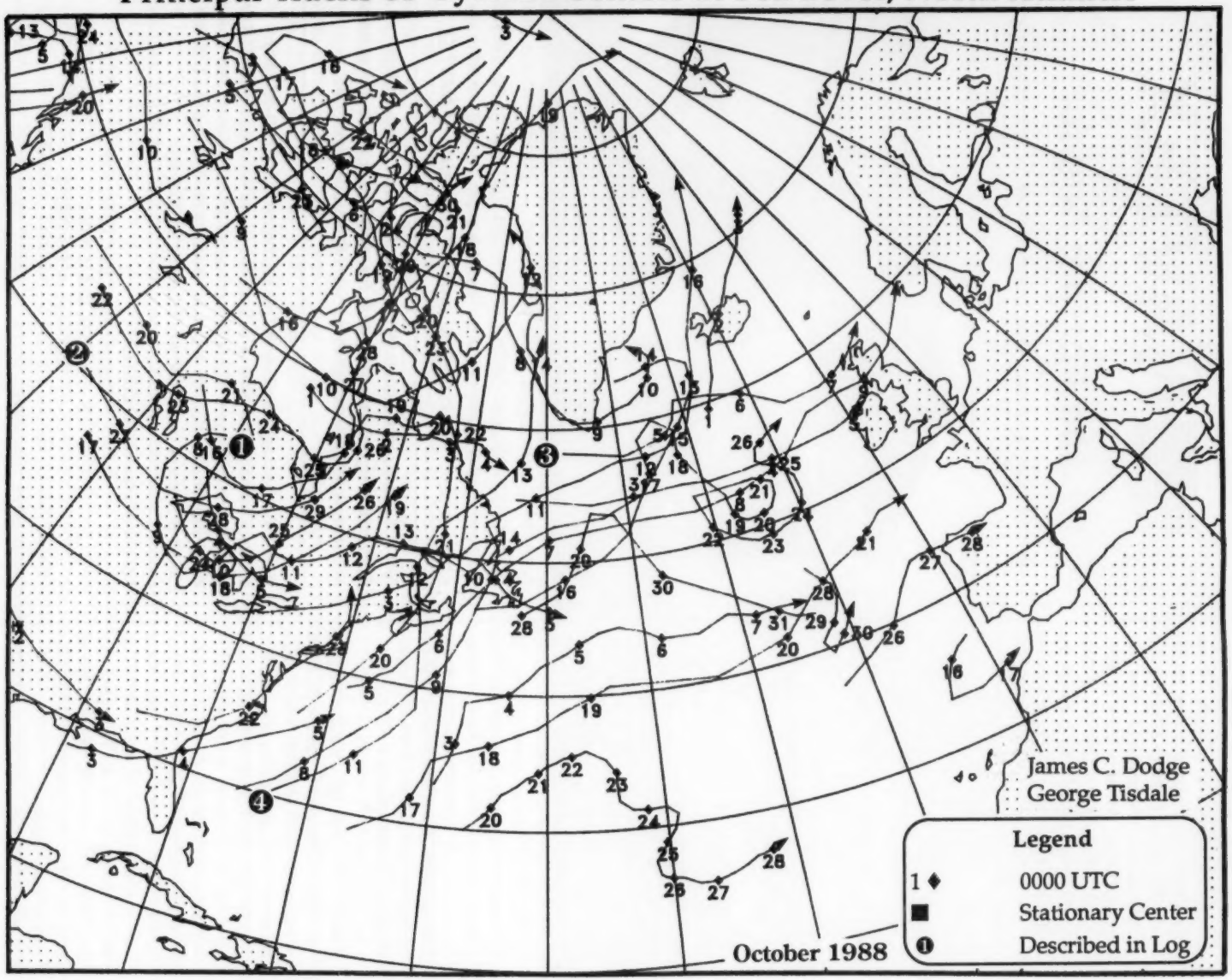
❶ This storm began innocently enough on the 24th, east of Hokkaido. After swinging east southeastward it began to turn toward the northeast the following day. On the 26th, as a 970–mb storm, it moved into the Bering Sea. At 0000 on the 26th the NNHB, near 56°N, 157°W, was whipped by 50–kn easterlies. The ***Sophia*** and ***Valentina*** reported west winds of 41 and 43 kn respectively at 1800, some 500 to 600 mi southeast of the center. The storm

reached its peak on the 27th as it approached Cape Avinof. By 1200 central pressure had dipped to 959 mb. Storm force winds were reported during the day by the ***Valentina, Century Highway No. 3, Skaugran, Princefield***, and the ***Cosmos Trader***. All were north of 50°N. The ***Princefield*** (51°N, 167°W) at 0000 on the 27th encountered 33–ft swells and 25–ft seas with a slope 1/3; this would indicate that the seas were breaking. The system moved onto the Alaska mainland, east of Bethel, late on the 27th. It headed northward across the Seward Peninsula and retained its identity as it moved into the Arctic Ocean on the 29th.

Tropical Cyclones— Only one tropical cyclone developed over the entire North Paific in December— Tropical Storm **Val**. The 13th saw a massive outbreak of cold air begin to push southeastward from Asia across the Philippine Sea. As this thrust diminished the southern Philippine Sea was the scene of deep convection. A trough formed and multiple low–level cyclonic circulations appeared in the trough. Finally the convection began to consolidate in the western Caroline Is. Out of all of this came tropical depression Val on the 22d. Val reached a peak intensity of 55 kn on the 24th at 0000. It slowed from a forward speed of about 25 kn to nearly stationary. Val was a shallow system, however, and was soon weakening as it slowly approached Luzon on the 25th and 26th. It fell below tropical storm intensity on the 25th at 1200 and dissipated east of Manila early on the 27th.

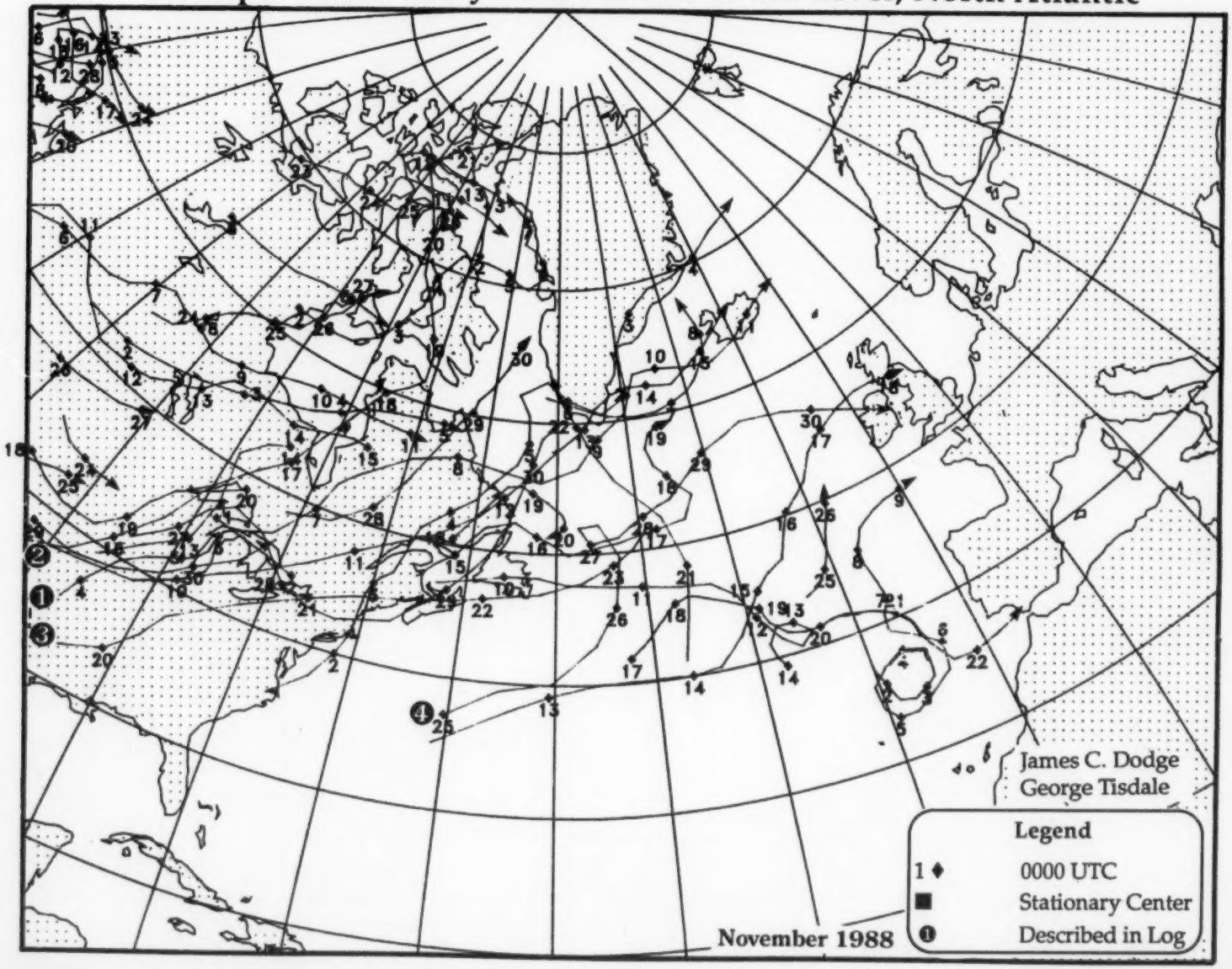
Casualties— Once again another Filipino ferry sunk. This time it was the ***RCJ*** off Semirara Is 190 mi south of Manila. This occurred in rough weather on the 18th. According to the Philippine Coast Guard 51 of the 53 people on board were missing. Survivors were picked up by the ***Sea Master***, after swimming in shark–infested seas for 7 hr. Another ferry sank about the time, off Hainan Is, drowning 62 of the 187 people on board. The vessel, on an educational excursion, was only 200 yd offshore, when she capsized. Most of the victims were children.

Principal Tracks of Cyclone Centers at Sea Level, North Atlantic

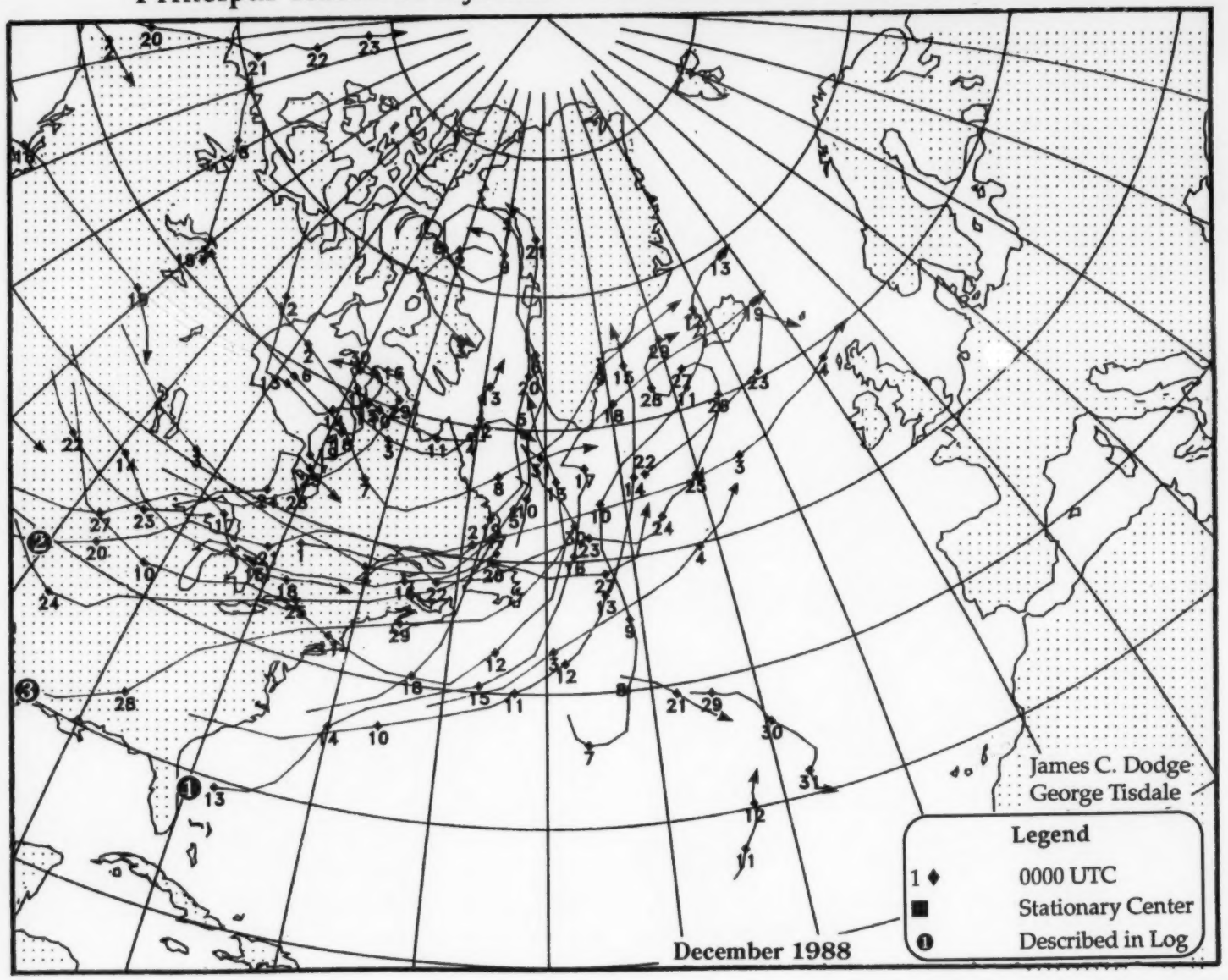


October 1988

Principal Tracks of Cyclone Centers at Sea Level, North Atlantic

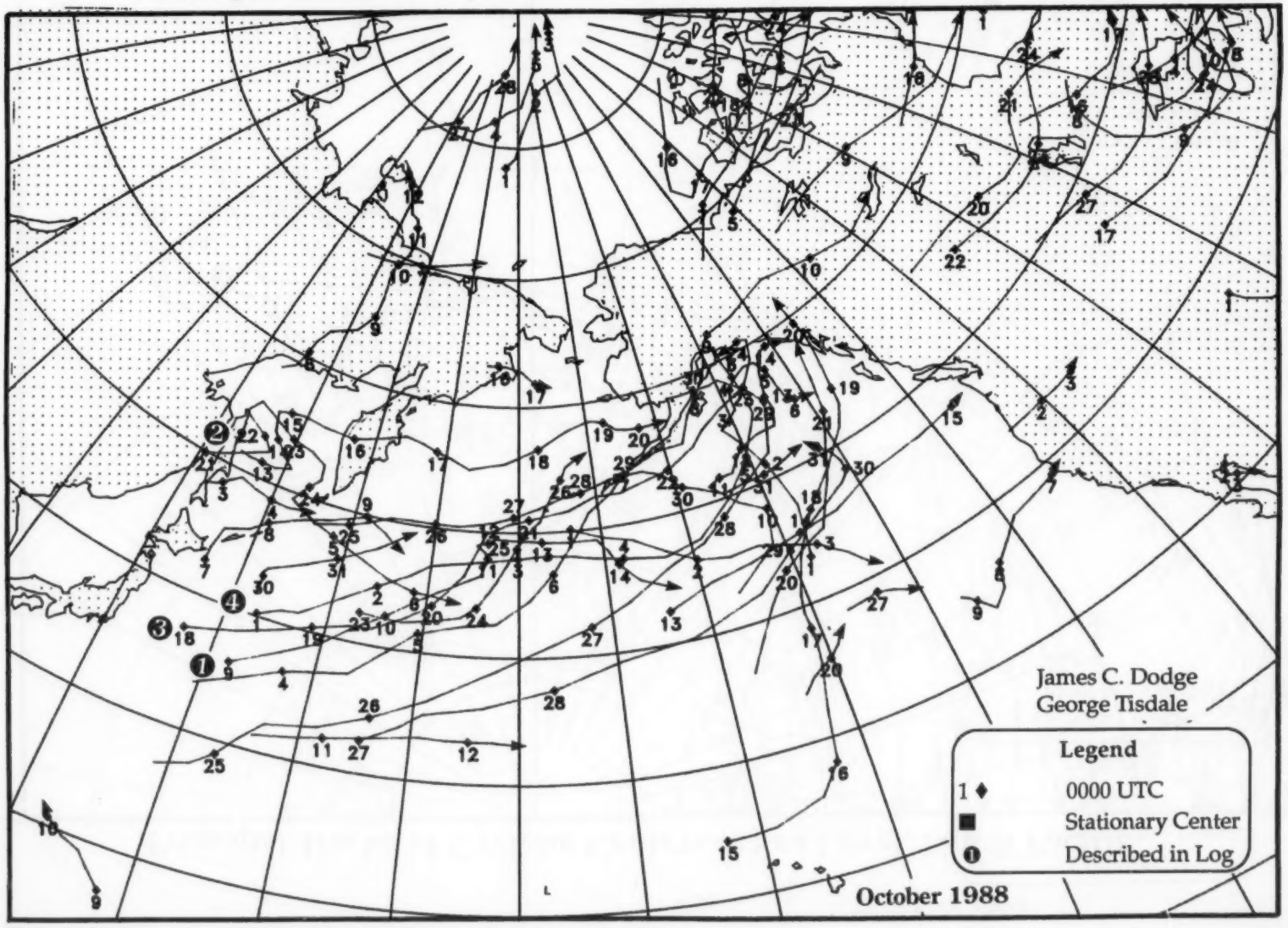


Principal Tracks of Cyclone Centers at Sea Level, North Atlantic

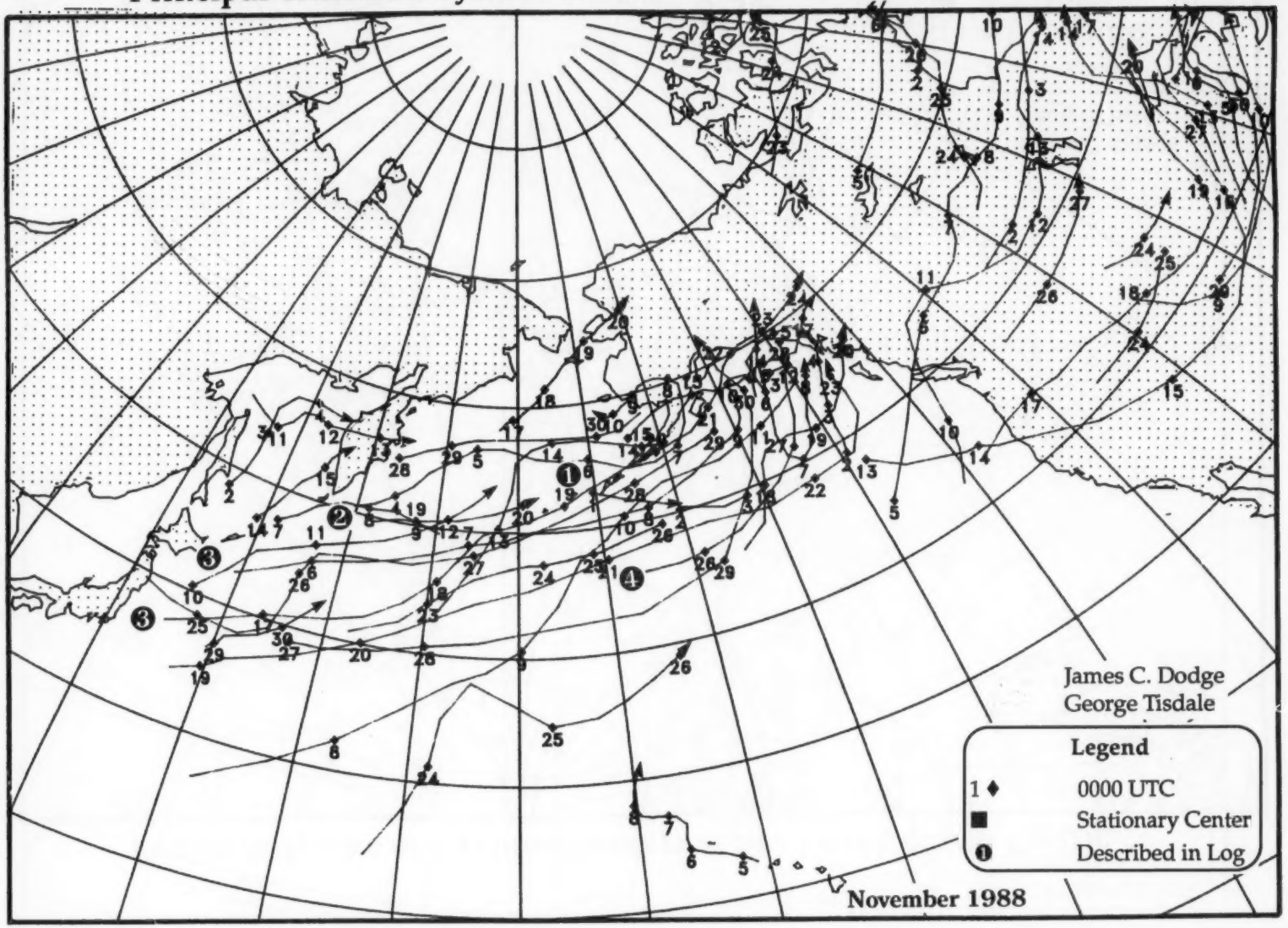


December 1988

Principal Tracks of Cyclone Centers at Sea Level, North Pacific

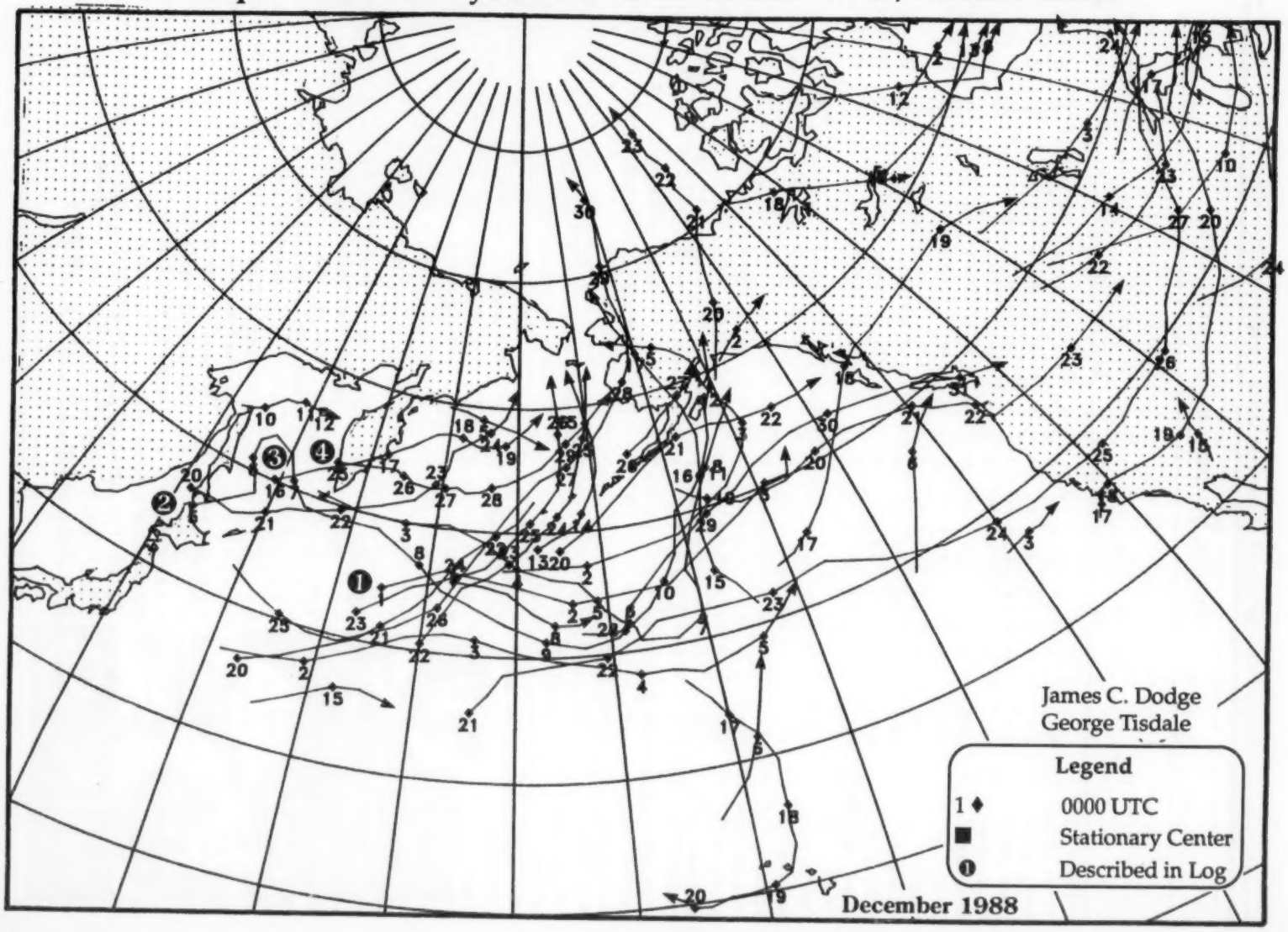


Principal Tracks of Cyclone Centers at Sea Level, North Pacific



November 1988

Principal Tracks of Cyclone Centers at Sea Level, North Pacific



October, November and December 1988

VESSEL	SHIP CALL	DATE	POSITION LAT. DEG.	POSITION LONG. DEG.	WIND TIME UTC	WIND DIR. 10 DEG.	WIND SPEED KN	VSBY NMI.	PRES WX. CODE	PRESS-URE MB	TEMP °C AIR	SEA TEMP °C SEA	SEA WAVES PD. SEC	SEA WAVES HGT. FT.	SWELL WAVES DIR	SWELL WAVES PD. SEC	SWELL WAVES HGT. FT.
PACIFIC OCT.																	
WESTWOOD MARIANNE	DUPU	6	47.2 N	175.2 W	06	26	M 53	.5 NM	28	0992.0	9.0	11.0	14	26	25	14	29.5
MARATHA MAJESTY	UUUV	13	39.7 N	156.8 E	06	18	45	50 YD	07	0999.5	20.0	20.0	XX	42.5	18	XX	41
MARATHA MAJESTY	UUUV	13	39.2 N	156.5 E	12	18	45	.5 NM	81	0997.7	18.0	20.0	XX	37.5	18	XX	37.5
SEALAND ENDURANCE	KGJX	30	35.5 N	151.1 E	18	28	M 83	10 NM		0999.1	16.7		10	19.5	27	12	32.5
ALBERT MAERSK	OYKZ2	30	38.3 N	151.7 E	18	28	55	5 NM	81	0992.6	12.5		6	24.5	30	13	32.5
CURRENT	3FKA2	31	37.0 N	159.9 E	00	24	M 58	2 NM		0998.0	19.0	19.0	10	28	24	12	29.5
CURRENT	3FKA2	31	37.0 N	161.4 E	06	25	M 55	2 NM		1002.5	17.0	16.0	10	31			
ALBERT MAERSK	OYKZ2	31	38.2 N	156.3 E	06	29	45	5 NM	81	1003.4	15.2		6	24.5	30	14	32.5
ALBERT MAERSK	OYKZ2	31	38.5 N	158.8 E	12	29	45	5 NM	02	1008.0	16.0		6	23	30	14	32.5
SEALAND INDEPENDENCE	WGJC	31	41.9 N	166.4 E	12	27	M 45	5 NM	01	0990.0	14.0		12	26	27	16	32.5
PACIFIC NOV.																	
PRESIDENT TRUMAN	WHDP	4	51.5 N	161.0 E	18	24	M 60	5 NM		0987.0	6.1	7.3	10	23	21	15	36
GREEN LAKE	KGTI	5	22.6 N	167.3 W	00	02	M 48	5 NM	81	1009.7	20.1	24.0	7	13	02	13	29.5
GREEN LAKE	KGTI	5	23.1 N	168.7 W	06	02	M 50	5 NM		1011.5	22.0		6	10	02	15	29.5
EXXON LONG BEACH	WHCA	22	50.6 N	134.8 W	20	30	M 70	1 NM	10	0968.0	9.0		6	14.5	30	10	29.5
WESTWARD VENTURE	KHJB	22	58.7 N	149.5 W	21	30	M 57	1 NM	88	0970.0	- 6.0	6.7	5	14.5	27	6	32.5
GREAT LAND	WFDP	23	51.9 N	133.7 W	00	29	M 50	.5 NM	59	0971.8	3.3	5.0	6	10	30	10	41
SANSIMENA II	WSIN	23	51.0 N	133.2 W	00	30	M 60	.5 NM	63	0970.0	5.6	11.1	8	29.5	28	15	26
GREAT LAND	WFDP	23	51.3 N	132.4 W	03	30	M 50	2 NM	51	0978.2	3.3	5.0	6	10	30	10	31
SANSIMENA II	WSIN	23	51.5 N	133.7 W	06	30	M 45	2 NM	21	0982.5	3.3	9.4	8	24.5	29	10	29.5
ALASKA RAINBOW	3ECL4	24	39.4 N	144.9 E	12	16	M 50	.25 NM	53	0993.0	14.0	13.0	14	24.5	16	18	29.5
HASSAN MERCHANT	3EPG2	25	35.2 N	143.0 E	06	26	M 47	5 NM		1002.0	15.8	19.0	11	29.5			
MOBIL MERIDIAN	KGSM	27	53.6 N	134.8 W	11	21	56	.5 NM	07	0971.0	7.2	7.7	4	6.5	18	8	32.5
MOBIL ARCTIC	KSPV	27	49.9 N	134.5 W	12	23	M 50	5 NM	02	0990.2	10.6	8.9	5	10	12	12	44
MOBIL ARCTIC	KSPV	27	50.1 N	134.8 W	16	25	M 50			0991.8	10.0	7.2	5	10	24	10	49
MOBIL ARCTIC	KSPV	27	50.2 N	134.8 W	18	25	M 50	5 NM	60	0996.1	9.4	7.2	8	29.5	26	15	59
ARCO CALIFORNIA	WNCV	27	53.5 N	135.2 W	18	25	M 60	2 NM	07	0976.5	5.6	5.6	6	32.5	25	12	32.5
MOBIL ARCTIC	KSPV	27	50.2 N	134.8 W	20	25	M 50	5 NM	21	0999.0	9.4	7.8	8	29.5	27	14	59
MOBIL ARCTIC	KSPV	27	50.4 N	135.0 W	22	29	M 45	5 NM	02	1002.9	9.4	7.8	5	19.5	28	14	44
MOBIL MERIDIAN	KGSM	27	52.6 N	133.6 W	23	27	47	2 NM	07	0995.5	7.7	7.7	4	8	25	9	41
ATLANTIC NOV.																	
MORMACSTAR	KGDF	14	41.7 N	38.8 W	12	33	48	5 NM	01	1016.1	12.5	18.8	6	14.5	33	10	29.5
AMERICAN RESOLUTE	KFDZ	21	39.9 N	69.1 W	13	27	50	5 NM	06	0999.0	12.8	17.8	7	19.5	26	8	29.5
KENNETH E. HILL	C6FA6	22	42.4 N	56.6 W	12	30	M 59	5 NM	15	0988.0	7.0		12	36	27	12	36
RAINBOW HOPE	KNDB	22	42.5 N	57.5 W	12	30	50			0990.0	4.4	12.2	8	24.5	29	10	39
RAINBOW HOPE	KNDB	23	42.0 N	54.5 W	00	32	48			0997.5	6.1		5	18	30	12	32.5
RAINBOW HOPE	KNDB	23	41.7 N	53.0 W	06	32	45	5 NM	02	1001.0	5.6		5	10	32	12	32.5
RAINBOW HOPE	KNDB	23	41.6 N	51.6 W	12	32	50	5 NM	02	1002.0	6.1	16.7	8	29.5	32	12	44
STAR EUVIUA	LAHE2	25	41.2 N	42.2 W	18	18	50	.5 NM	50	0978.0		20.0	11	29.5	18	13	29.5
RAINBOW HOPE	KNDB	26	49.4 N	40.5 W	12	20	65	1 NM	59	0968.0	11.1	16.1	10	34.5	18	12	59
RAINBOW HOPE	KNDB	26	49.4 N	40.4 W	15	21	65	2 NM	05	0976.0	11.1	15.0	10	34.5	22	14	49
RAINBOW HOPE	KNDB	26	50.0 N	40.0 W	18	21	50			0974.5	12.2	19.9	3	6.5	21	14	49
PACIFIC DEC.																	
TERESA O.	DUVA	2	48.0 N	141.0 W	18	16	M 58	200 YD	60	0989.0	8.0	11.0	6	14.5	16	10	29.5
MOBIL ARCTIC	KSPV	2	57.3 N	142.4 W	23	14	M 55	2 NM	62	0984.0	7.2	5.0	4	14.5	14	15	34.5

VESSEL	SHIP CALL	DATE	POSITION LAT. DEG.	POSITION LONG. DEG.	WIND TIME UTC	WIND DIR. 10 DEG.	WIND SPEED KN	VSBY NMI.	PRES WX. CODE	PRESS-URE MB	TEMP °C AIR	TEMP °C SEA	SEA WAVES PD. SEC	SEA WAVES HGT. FT.	SWELL WAVES DIR	SWELL WAVES PD. SEC	SWELL WAVES HGT. FT.
MOSAC TASCO	3EHH5	3	44.6 N	156.1 E	00	27	50	2 NM	60	1012.0	0.0	6.0	10	29.5	27	12	32.5
MOBIL ARCTIC	KSPV	3	57.3 N	142.2 W	06	14	67	2 NM	62	0977.5	7.2	5.0	9	44	14	20	32.5
ARCO CALIFORNIA	WNCV	3	52.2 N	136.5 W	06	15	90	.5 NM		0995.0	5.6	6.7			24	9	39
MOBIL ARCTIC	KSPV	4	56.5 N	141.5 W	06	24	54	10 NM	23	0991.7	4.4	5.6	7	14.5	19	14	29.5
MOSAC EXPRESS	3EUO5	11	53.9 N	159.4 W	18	31	52	2 NM	07	0988.5	- 3.0	5.1	11	19.5	31	14	32.5
EXXON BENICIA	KPKL	15	39.0 N	125.0 W	00	34	57	5 NM		1017.0	15.6	11.1	4	10	34	10	32.5
SEALAND INDEPENDENCE	WGJC	16	49.2 N	156.7 W	00	27	47	5 NM	61	0996.2	3.0	7.0	9	32.5	30	11	19.5
MOSAC TASCO	3EHH5	19	48.5 N	152.5 W	18	28	50	5 NM		1005.0	5.5	6.0	8	32.5			
CHEVRON CALIFORNIA	WCGH	21	43.9 N	130.1 W	00	28	45	5 NM	25	1003.0	9.4	10.6	3	8	30	10	34.5
CHEVRON CALIFORNIA	WCGH	21	44.0 N	130.1 W	06	29	65	5 NM		1004.1	9.4	11.1	3	8	29	XX	46
CHEVRON CALIFORNIA	WCGH	21	43.8 N	130.6 W	12	30	55	2 NM		1013.2	10.0	11.1	10	49			
LEISE MAERSK	OXDW2	27	47.4 N	173.4 W	00	24	48	5 NM		0997.0	5.0		XX	32.5			
SOLAR WING	3EKY6	29	37.9 N	178.2 E	00	15	57	10 NM		1008.0	15.0	15.0	8	31	15	14	13
ATLANTIC DEC.																	
CHERRY VALLEY	WIBK	1	32.2 N	40.8 W	00	35	47	5 NM	25	1014.0	20.0	20.0	9	24.5	36	16	29.5
CHERRY VALLEY	WIBK	2	35.7 N	37.2 W	00	04	47	2 NM	25	1021.0	18.3	17.8	10	36	36	15	29.5
SEALAND PERFORMANCE	KAPD	14	36.8 N	60.6 W	21	23	60	.25 NM			19.0		8	29.5	23	12	29.5
SEALAND PERFORMANCE	KAPD	15	36.4 N	60.3 W	00	23	60			0989.0	17.0		8	29.5	23	12	32.5
CHERRY VALLEY	WIBK	25	42.0 N	35.2 W	00	29	45	5 NM	80	1006.5	10.0	13.3	10	26	29	12	39
LICA MAERSK	OXPS2	25	54.1 N	34.4 W	12	30	50	5 NM		0978.5	5.0		15	32.5			
CHERRY VALLEY	WIBK	26	39.0 N	43.8 W	12	24	47	5 NM	80	1016.8	18.3	14.4	8	29.5	23	9	36

October, November and December 1988

Ship Name	radio	mail
1ST LT ALEX BONNYMAN	23	
1ST LT JACK LUMMIS	89	106
2ND LT. JOHN P. BOBO	8	12
A. V. KASTNER	48	
ABBEY	169	
ACE ACCORD	105	150
ACE ENTERPRISE		131
ACT 11	37	
ACT 111	179	
ACT 12	33	
ACT 5	171	
ACT 6	182	
ACT 7	142	
ACT 9	52	
ACT I	125	
ACT IV	210	
ADABELLE LYKES	57	51
ADDIRIYAH	25	34
ADMIRALTY BAY	34	97
ADONIS	31	66
ADRIAN MAERSK	34	61
AFRICAN FERN	77	71
ALAIN LD	6	
ALANTIC ANGEL	12	12
ALASKA RAINBOW	22	125
ALBERT MAERSK	38	99
ALDEN W. CLAUSEN	42	77
ALEMANIA EXPRESS	94	
ALISON	2	
ALLIGATOR FORTUNE	38	88
ALLIGATOR GLORY	28	60
ALLIGATOR HOPE	69	147
ALLIGATOR LIBERTY	51	
ALLIGATOR TRIUMPH	37	62
ALMERIA LYKES	36	76
ALMUDENA	1	
ALTAMONTE	28	29
ALVA MAERSK	23	21
AMBASSADOR	41	144
AMBASSADOR BRIDGE	97	66
AMELIA TOPIC	26	
AMERICA EXPRESS	56	
AMERICA SUN		4
AMERICAN ALABAMA	57	160
AMERICAN CONDOR	7	10
AMERICAN CORMORANT	12	
AMERICAN EAGLE	63	87
AMERICAN FALCON	11	102
AMERICAN KESTREL	17	69
AMERICAN MAINE	37	111
AMERICAN MARINER		89
AMERICAN NEW YORK	77	156
AMERICAN REPUBLIC		130
AMERICAN RESOLUTE	34	92
AMERICAN TROJAN	28	40
AMERICAN UTAH	40	157
AMERICAN VIRGINIA	51	143
AMERICANA	57	106
ANTHONY RAINBOW	47	135
AQUA CITY	88	143
AQUA GARDEN	38	121
AQUARIUS	73	185
ARCO ALASKA	33	52
ARCO ANCHORAGE	21	23
ARCO CALIFORNIA	15	43
ARCO FAIRBANKS	31	42
ARCO INDEPENDENCE		20
ARCO JUNEAU	26	15
ARCO PRUDHOE BAY	2	25
ARCO SAG RIVER	8	4
ARCO SPIRIT	3	
ARCO TEXAS	18	34
ARCTIC TOKYO	4	173
ARGONAUT	41	161
ARILD MAERSK	112	96
ARIOSTO AMADO	58	
ARMCO	130	290
ARNOLD MAERSK	23	127
ARTHUR M. ANDERSON	192	228
ARTUS		34
ASHLEY LYKES	40	
ASIAN VENTURE		4
ASPEN	23	54
ASTERIKS	42	
ASTORIA	109	
ASTRO JYOJIN	13	30
ATIGUN PASS	127	302
ATLANTIC	99	126
ATLANTIC CARTIER	73	
ATLANTIC COMPANION	69	
ATLANTIC CONVEYOR	110	
ATLANTIC RAINBOW	29	55
ATLANTIC SPIRIT	68	67
ATLANTIS II	1	
ATLAS HIGHWAY	9	
AURORA	2	
AURORA ACE	113	
AUSTANGER	11	27
AUSTRAL RAINBOW	36	34
B.T. ALASKA	60	157
B.T. SAN DIEGO	99	282
BAAB ULLAH	58	77
BACTAZAR	60	61
BADGER	2	24
BANGLAR KALLOL	3	
BAR' ZAH	41	63
BARBER HECTOR	43	
BARBER HAAA	9	
BARBER PERSEUS	56	
BARBER TAMPA	16	
BARBER TOBA	1	
BARRYDALE	117	
BAY BRIDGE	100	96
BCR KING	47	
BEACON	1	
BEER SHEVA	14	
BELLE RIVER		357
BENSON FORD		124
BHAVABHUTI	1	
BIBI	137	
BISLIG BAY	37	
BLUE HAWK	48	
BOGASARI DUA	25	69
BOGASARI LIMA	43	67
BOLIVAR	38	133
BRIGIT MAERSK	40	149
BRILLIANT ACE	83	
BROOKLYN	12	40
BROOKLYN BRIDGE	209	
BROOKS RANGE	44	68
BUNGA CHEMPAKA	1	
BUNGA KENANGA	8	
BUNGA KESIDANG	5	
BUNGA MELAWIS	38	
BUNGA TEMBUSU	59	81
BURNS HARBOR		211
C.MEHMET	6	46
CAGUAS	41	131
CALCITE II	69	92
CANADIAN RAINBOW	10	142
CAPE BYRON	60	
CAPE ROGER	95	
CAPE YORK	119	
CAPRICORN	8	30
CARIBE I	2	50
CARLA A. HILLS	7	136
CAROLINA	32	109
CASON J. CALLAWAY	87	113
CAUSARINA	3	43
CELEBRATION	1	96
CGM LORRAINE	49	
CHACO	19	
CHARLES M. BEEGHLEY	123	210
CHARLES PIGOTT		103
CHARLOTTE LYKES	68	116
CHELSEA	34	74
CHEMICAL PIONEER	25	45
CHERRY VALLEY	41	168
CHESAPEAKE BAY	19	133
CHESAPEAKE TRADER	128	219
CHESNUT HILL	15	22
CHEVRON ANTWERP	13	195
CHEVRON ARIZONA	32	44
CHEVRON BURNABY	68	176
CHEVRON CALIFORNIA	95	181
CHEVRON COPENHAGEN		4
CHEVRON EDINBURGH	55	81
CHEVRON EQUATOR	36	59
CHEVRON LONDON		134
CHEVRON LOUISIANA	37	59
CHEVRON LOUSIANA		37
CHEVRON METEOR	68	208
CHEVRON MISSISSIPPI	105	169
CHEVRON NAGASAKI		75
CHEVRON PACIFIC	73	155
CHEVRON SKY		279
CHEVRON STAR		143
CHEVRON SUN	2	204
CHIA FU	12	
CHICKASAW	46	
CHRISTINA	79	
CIELO DI VENEZIA	6	11
CITADEL HILL	111	
CITY OF MIDLAND	13	62
CLARENCE	113	
CLEMENT	114	
CO-OP EXPRESS I	32	
CO-OP EXPRESS II	29	
COAST RANGE	9	34
COASTAL MANATEE	19	9
COLIMA	72	123
COLUMBIA STAR		148
COLUMBUS AMERICA	79	
COLUMBUS AUSTRALIA	84	
COLUMBUS CANADA	57	
COLUMBUS ISELIN		9
COLUMBUS LOUISANA	102	
COLUMBUS NEW ZEALAND	122	
COLUMBUS OHIO	6	
COLUMBUS VICTORIA	128	
COLUMBUS VIRGINIA	114	
COLUMBUS WELLINGTON	141	
CONCERT EXPRESS	56	
CONCHO	3	
CORAH ANN	1	
CORMORANT ARROW	42	
CORNUCOPIA	81	218
CORONADO	28	66
COURTNEY BURTON	115	152
CPL. LOUIS J. HAUGE JR	26	16
CUENCA	1	121
CURRENT	41	85
CYGNUS	25	36
CYPRESS TRAIL	70	95
D.L. BOWER		245
DELAWARE BAY	23	35
DELAWARE TRADER	36	72
DIANA	2	14
DILIGENCE TRADER	5	104
DOCK EXPRESS TEXAS	26	227
DONA CORAZON II	1	
DUBHE	58	100
DUSSELDORF EXPRESS	51	
E.A. BRUSSEL	68	21
EASTERN FRIENDSHIP	23	60
EASTERN GLORY	37	63
EASTERN VENTURE	22	54
EDGAR B. SPEER		254
EDGAR M. QUEENY	45	100
EDWARD L. RYERSON	159	337
EDWIN H. GOTT		149
EL GAUCHO	16	
ELBE MARU	88	
ELIZABETH LYKES	17	40
EMERALD SEA	164	105
ENDEAVOR	22	35
ENSOR	40	143
EUPEN	14	
EVER BETTER	1	
EVER GAINING	48	10
EVER GARDEN	9	
EVER GATHER	11	
EVER GENIUS	8	13
EVER GENTLE	13	7
EVER GENTRY		17
EVER GIANT	26	
EVER GIFTED	3	
EVER GIVEN	8	
EVER GLEAMY	13	
EVER GLOBE	14	
EVER GLORY	24	
EVER GOLDEN	6	
EVER GOODS	3	4
EVER GOVERN	3	16
EVER GRACE	32	34
EVER GRADE	5	22
EVER GRAND	3	25
EVER GROUP	6	9
EVER GROWTH	8	31
EVER GUARD	31	61
EVER GUIDE	26	20

Ship Name	radio	mail
EVER LINKING	1	2
EVER LOADING	5	
EVER ORDER	22	17
EVER SPRING	32	38
EVER SUMMIT	28	115
EVER SUPERB	44	
EVER VALOR	3	
EVER VALUE	3	
EVER VIGOR	11	9
EVER VITAL	4	
EXPORT FREEDOM	18	119
EXPORT PATRIOT	22	104
EXXON BALTIMORE	15	33
EXXON BATON ROUGE	21	52
EXXON BENICIA	65	60
EXXON BOSTON	2	26
EXXON LEXINGTON	1	
EXXON LONG BEACH	25	60
EXXON NEW ORLEANS	12	18
EXXON NORTH SLOPE	6	13
EXXON PHILADELPHIA	10	9
EXXON PRINCETON	9	37
EXXON SAN FRANCISCO	33	54
EXXON VALDEZ	8	16
EXXON YORKTOWN	31	28
FALCON LEADER	62	68
FARNELLA	75	
FERNCROFT	89	143
FESTIVALE	4	
FETISH		109
FIGARO	11	43
FINNROSE	34	128
FLORIDA RAINBOW	82	203
FORTALEZA	68	245
FRANCIS SINCERE NO. 6	33	26
FRED A. WHITE		85
FREDERICKSBURG	15	50
FREEZER LYNX	1	
FROTASIRIUS	31	
GALVESTON BAY	26	202
GATEWAY EAST	80	113
GEMINI	57	90
GENERAL M.BELGRANDO	5	
GENEVIEVE LYKES	2	25
GEORGE A. SLOAN	92	63
GEORGE A. STINSON		229
GEORGE H. WEYERHAEUSER	16	22
GEORGE WASHINGTON BRID	218	
GEORGIA		46
GLACIER BAY	32	127
GLENEAGLES	7	17
GLORIA	8	
GLORIOUS SPICA	82	
GOLAR PETROSUN	7	24
GOLDEN APO	38	
GOLDEN BLISS	56	63
GOLDEN ENDEAVOR	68	137
GOLDEN GATE		5
GOLDEN GATE BRIDGE	191	74
GOLDEN HAWK	81	194
GRAIGLAS	138	
GREAT LAND	209	195
GREEN ANGELES	9	16
GREEN BAY	68	171
GREEN HARBOUR	80	51
GREEN ISLAND	76	158
GREEN LAKE	74	169
GREEN MASTER	50	66
GREEN MAYA	51	77
GREEN RIDGE	86	260
GREEN SAIKAI	10	53
GREEN SASEBO	43	49
GREEN STAR	34	187
GREEN VALLEY	39	90
GREEN WAVE	71	202
GUANAJUATO	66	1
GUAYAMA	30	96
GULF IDEAL	53	92
GYPSUM BARON	166	
GYPSUM COUNTESS	177	
GYPSUM KING	258	
HAI JUNG	9	
HAMBURG	1	
HANEI PEARL	31	
HANEI SKY	41	105
HANEI SUN	71	56
HANJIN BUSAN	6	
HANJIN CHEJU	4	
HANJIN HONG KONG	24	19
HANJIN KEELUNG	31	10
HANJIN KOBE	7	
HANJIN KUNSAN	24	
HANJIN KWANGYANG	14	27
HANJIN LONG BEACH	8	
HANJIN NEW YORK		23
HANJIN POHANG	28	
HANJIN SAVANNAH	35	42
HANJIN SEOUL	40	35
HANJIN YOKOHAMA	19	8
HANSA BERGEN	28	
HARMAC DAWN	128	
HASSAN MERCHANT	129	168
HAWAIIAN RAINBOW	22	63
HAWTHORN HILL	44	85
HEEREMGRAAHT	54	
HEIDE	39	
HEILBRONN	1	
HENRY FORD II		25
HENRY HUDSON BRIDGE	235	
HENRY STEINBRENNER	45	73
HERBERT C. JACKSON	29	
HERMENIA	24	29
HIRA #2	97	31
HIYOSHI MARU	114	
HOEGH CAIRN	5	12
HOEGH CLIPPER	11	35
HOEGH DENE		72
HOEGH DYKE	36	75
HONSING BREEZE	20	50
HOJIN MARU	173	
HOLIDAY	25	49
HOLSTEN TRADER	19	
HONESIA	79	202
HONOLULU	100	
HRELJIN	22	
HUAL ROLITA	3	
HUAL TRANSPORTER	48	160
HUMACAO	40	161
HUMBER ARM	63	122
HYUGA MARU	98	
HYUNDAI #103	2	
HYUNDAI #203	8	
HYUNDAI #206	108	
HYUNDAI CHALLENGER	86	41
HYUNDAI COMMANDER	76	71
HYUNDAI EXPLORER	5	51
HYUNDAI INNOVATOR		7
HYUNDAI PIONEER	47	
IBIS ARROW	42	
INCOTRANS PACIFIC	177	
INFANTA	124	
INGER	80	226
IRMA M	181	
IRVING L. CLYNER	113	141
ISLAND PRINCESS	103	
ITALICA	40	87
ITAMAGE	22	24
ITAPE	41	
ITB PHILADELPHIA	125	162
J.A.W. IGLEHART		71
J.L. MAUTHE	69	115
JADRAN EXPRESS	5	
JALISCO	41	202
JAMES LYKES	23	79
JAMES A. BARKER		70
JAPAN ALLIANCE	74	41
JAPAN APOLLO	109	110
JAPAN STORK	7	
JEAN LYKES	7	24
JO BIRK	202	
JO CLIPPER	54	
JO CYPRESS	54	
JO GRAN	63	123
JO LONN	127	
JO OAK	50	
JOHANNA OLDENDORFF	45	
JOHN G. MUNSON	177	166
JOHN LYKES	1	
JOSEPH H. FRANTZ	52	83
JOSEPH L. BLOCK		14
JOSEPH LYKES	20	29
JOVIAN LILY	55	172
JSS MEONIA	31	
JUBILEE	6	
JULIUS HANNER	3	143
KAHARDA	2	
KALIDAS	43	
KASIKA	29	15
KASTURBA	6	
KAURI	85	218
KEE LUNG	26	100
KEISHO MARU	73	44
KEMAI	21	18
KENNETH E. HILL	82	194
KENNETH T. DERR	23	98
KENT	42	86
KENTUCKY HIGHWAY	74	
KEYSTONE CANYON	2	6
KEYSTONER	42	147
KIILSA	6	47
KINGS POINTER	3	
KISO	117	
KITTANNING	2	7
KOLN EXPRESS	19	
KOPER EXPRESS	38	
KOREAN WONIS JIN	17	
KOREAN WONIS ONE	35	42
KOREAN WONIS SEVEN	53	31
KOREAN WONIS SUN	24	16
KONYU MARU	35	
KUNOBE	79	
LA PAMPA	11	
LAMETTE	1	
LARS MAERSK	26	66
LASH ATLANTICO	13	55
LAURA MAERSK	39	79
LAUST MAERSK	34	88
LAWRENCE A. GIANELLA	53	34
LEDA MAERSK	25	97
LEISE MAERSK	18	109
LEO TEMPEST	76	73
LERNA	183	
LESLIE LYKES	6	
LETITIA LYKES	59	109
LEWIS WILSON FOY		354
LEXA MAERSK	25	156
LIBERTY STAR	11	
LIBERTY SUN	84	75
LIBERTY WAVE	12	
LICA MAERSK	47	131
LILLY STAR	2	
LING LEO	20	201
LIONS GATE BRIDGE	41	101
LIRCAY	18	34
LLOYD ITAJAI	87	
LLOYD MARANHAO	2	318
LLOYD SAO PAULO	85	
LLOYD SERGIPA	3	
LNG TAURUS	45	162
LONG LINES	111	48
LOTUS ACE	113	
LOUIS MAERSK	28	98
LOUISE LYKES	24	
LOUISIANA BRIMSTONE	33	130
LURLINE	38	135
LUZON	24	63
LYRA	48	79
M. P. GRACE	72	
M.T. MILE	1	
M/V MARINE RELIANCE	22	62
MACKINAC BRIDGE	218	
MADAME BUTTERFLY	16	
MAERSK CONSTELLATION	85	72
MAERSK TACOMA	5	
MAERSK WIND	53	143
MAGALLANES	52	139
MAJ SANDVED	23	
MAJ SIF	109	112
MAJ STEPHEN W PLESS MP	7	12
MAKILING	35	60
MALLORY LYKES	43	84
MANGAL DESAI	9	
MANHATTAN BRIDGE	163	
MANINGNING	53	151
MANUKAI	51	143
MANULANI	67	177
MARATHA MAJESTY	49	184
MARCHEN MAERSK	74	161
MARGARET LYKES	89	136
MARIA TOPIC	29	
MARIF	34	42
MARIT MAERSK	29	80
MARITIME ASSOCIATE	48	70
MARJORIE LYKES	45	
MASON LYKES	44	116
MATSONIA	63	212
MAUI	60	194
MAWASH TAPUK	13	
MAYAGUEZ	1	1
MC KINNEY MAERSK	39	115
MEDALLION	72	113
MEDUSA CHALLENGER	37	164
MELBOURNE HIGHWAY	20	12
MELGAR BAY	17	37
MELVILLE	93	116
MERAK EIGHTY	70	81
MERCANDIAN CONTINENT	14	44
MERCANDIAN SUN II	87	188
MERIDA	20	5
MESABI MINER		160
MICHIGAN		19
MICHIGAN HIGHWAY	57	

Ship Name	radio	mail
MICRONESIAN COMMERCE	7	24
MICRONESIAN INDEPENDEN	20	111
MIDDLETOWN	124	209
MILTA	17	85
MINERAL HOBOKEN	1	
MINERVA	22	
MING ENERGY	1	
MING FORTUNE	22	60
MING GALAXY	1	31
MING MERCY	4	
MING MOON	33	
MING OCEAN	1	
MING SPRING	24	
MOANA PACIFIC	268	238
MOANA WAVE	5	
MOBIL ARCTIC	23	169
MOBIL MERIDIAN	152	222
MOKU PAHU	71	106
MONSUN	64	41
MONTRACHET	1	
MORELOS	42	114
MORNACSKY	47	156
MORNACSTAR	55	138
MORNACSUN	15	138
MOSEL EXPRESS	115	
MOSMAN STAR	14	
MOUNT VERNON VICTORY		32
MYRON C. TAYLOR	120	104
NACIONAL SANTOS	3	
NANCY LYKES	15	40
NATIONAL DIGNITY	46	207
NATIONAL HONOR	16	48
NATIONAL PRIDE	28	
NAVIGATOR		85
NAVIOS ENTERPRISE	15	
NAVIOS UNIQUE	75	
NECHES	2	24
NEDLLOYD ELBE	97	
NEDLLOYD HUDSON	53	155
NEDLLOYD KATWIJK	154	
NEDLLOYD KEMBLA	88	
NEDLLOYD KIMBERLEY	1	
NEDLLOYD KINGSTON	69	
NEDLLOYD KYOTO	96	
NEDLLOYD ROCHESTER	106	
NEDLLOYD ROSARIO	128	
NEDLLOYD ROTTERDAM	85	
NEDLLOYD ROUEN	111	
NEPTUNE	2	7
NEPTUNE ACE	81	
NEPTUNE AMBER	133	
NEPTUNE CORAL	81	28
NEPTUNE DIAMOND	200	
NEPTUNE GARNET	32	
NEPTUNE IVORY	86	
NEPTUNE JADE	30	
NEPTUNE PEARL	72	42
NEPTUNE TOURMALINE	21	
NEW HORIZON		170
NEW INDEPENDENCE	34	64
NEW NOBLE	5	
NEW TURQUOISE	46	69
NICOLET	8	
NISSAN LAUREL	8	
NISSAN MARU	9	
NOAA DAVID STARR JORDA	214	217
NOAA SHIP ALBATROSS IV	146	172
NOAA SHIP CHAPMAN	203	75
NOAA SHIP DAVIDSON	245	268
NOAA SHIP DELAWARE II	384	242
NOAA SHIP DISCOVERER 0	212	238
NOAA SHIP FERREL	161	169
NOAA SHIP HECK 591	42	99
NOAA SHIP JOHN N COBB	33	40
NOAA SHIP MCARTHUR	445	262
NOAA SHIP MILLER FREEM	137	150
NOAA SHIP MT MITCHEL	63	68
NOAA SHIP OCEANOGRAPHE	181	
NOAA SHIP OREGON II	309	144
NOAA SHIP RAINIER	130	
NOAA SHIP SURVEYOR	152	222
NOAA SHIP T. CROMWELL	333	372
NOAA SHIP WHITING	233	261
NORDHVAL	4	
NOSAC EXPRESS		125
NOSAC RANGER	25	137
NOSAC SKAUKAR	36	48
NOSAC SKY	16	
NOSAC TAI SHAN	9	13
NOSAC TAKARA	41	39
NOSAC TAKAYAMA	75	57
NOSAC TASCO	6	86
NOSAC TRIGGER	58	202
NOSIRA SHARON	146	

Ship Name	radio	mail
NUEVO SAN JUAN	9	161
NURNBERG EXPRESS	103	
OAXACA	43	
OCEAN BRIDGE	28	
OCEAN CHEER	12	
OCEAN COMMANDER #1	47	17
OCEAN LEGEND	9	
OCEAN LUCKY	29	190
OCEAN SEL	22	72
OCEAN STEELHEAD	37	137
OGDEN WABASH	1	
OLEANDER	101	117
OLGA TOPIC	48	192
OLIVE ACE	33	19
OMI CHAMPION	9	
ORANGE ACE	1	
ORANGE BLOSSOM	91	275
ORANGE STAR		20
ORCHID	57	15
ORCHID #2	30	54
OREGON RAINBOW II	42	200
ORIENTAL DIPLOMAT	42	
ORIENTAL EDUCATOR	4	
ORIENTAL EXPLORER	163	225
ORIENTAL FAIR	59	27
ORIENTAL FAITH	36	
ORIENTAL FORTUNE	36	
ORIENTAL FREEDOM	149	
ORIENTAL FRIENDSHIP	63	145
ORIENTAL MINISTER	22	
ORIENTAL PATRIOT	45	178
ORIENTAL PHOENIX		234
ORION HIGHWAY	64	
OVERSEAS ALICE	17	
OVERSEAS BOSTON		51
OVERSEAS CHICAGO	36	95
OVERSEAS HARRIET	52	100
OVERSEAS JOYCE	1	
OVERSEAS JUNEAU	35	28
OVERSEAS MARILYN	52	120
OVERSEAS OHIO	3	16
OVERSEAS VALDEZ		34
OVERSEAS VIVIAN	16	28
OVERSEAS WASHINGTON	10	
PACDUCHESS	52	
PACDUKE	5	
PACEMPEROR	41	
PACGLORY	47	
PACIFIC ANGEL	14	10
PACIFIC ARROW	88	75
PACIFIC DAWN	13	
PACIFIC PRINCESS	90	
PACIFIC RAINBOW	6	114
PACIFIC VENTURE	13	
PACIFIC VICTORY	18	30
PACIFIC WING	68	
PACKING	81	
PACMAJESTY	36	
PACMERCHANT	16	
PACNOBLE	4	
PACPRINCE	20	
PACPRINCESS	27	44
PAN FORTUNE	16	
PANCALDO		8
PATRIOT	23	
PAUL BUCK	44	107
PECOS	4	15
PEGGY DOW	89	
PENNSYLANIA RAINBOW	36	73
PENNSYLVANIA TRADER	21	75
PERNEKE	18	
PETER W. ANDERSON		7
PETERSFIELD	77	
PFC EUGENE A. OBREGON	11	26
PFC JAMES ANDERSON JR	10	
PFC WILLIAM B. BAUGH	15	48
PHAROS	99	
PHILIP A. CLARKE	152	207
PHILIPPINE VICTORY	11	
PILAR	5	43
PING CHAU	28	
POCAHONTAS	3	
POLAR ALASKA	13	183
POLYNESIA	201	
POMEROL	11	104
PONCE	1	
POQUITA MAMI	88	255
PORTLAND	119	175
POTOMAC TRADER	23	72
PRESIDENT ADAMS	30	64
PRESIDENT ARTHUR	57	191
PRESIDENT BUCHANAN	80	154
PRESIDENT CLEVELAND	17	
PRESIDENT EISENHOWER	121	195

Ship Name	radio	mail
PRESIDENT F. ROOSEVELT	45	95
PRESIDENT GARFIELD	66	150
PRESIDENT GRANT	62	154
PRESIDENT HARDING	87	169
PRESIDENT HARRISON	107	154
PRESIDENT HOOVER	26	86
PRESIDENT JACKSON	4	76
PRESIDENT JEFFERSON	7	
PRESIDENT JOHNSON	9	
PRESIDENT KENNEDY	71	160
PRESIDENT LINCOLN	77	190
PRESIDENT MADISON	72	79
PRESIDENT MONROE	106	33
PRESIDENT PIERCE	22	37
PRESIDENT POLK	66	194
PRESIDENT TAYLOR	22	26
PRESIDENT TYLER	61	59
PRESIDENT VAN BUREN	48	56
PRESIDENT WASHINGTON	93	115
PRESQUE ISLE		276
PRIMORJE	13	
PRINCE OF TOKYO	44	153
PRINCE WILLIAM SOUND	18	49
PRINCESS DIAN	36	172
PUERTO RICO	1	
PUNTA BRAVA	1	
PURITAN	183	
PVT HARRY FISHER	16	34
QUEEN ELIZABETH 2	56	
QUEENS WAY BRIDGE	1	
RAINBOW BRIDGE	95	43
RAINBOW HOPE	173	225
RALEIGH BAY	25	176
RANGER	58	7
REGINA MAERSK	28	98
RESERVE	56	138
RHINE FOREST	28	119
RICH VICTORIA	83	
RICHARD G MATTIESEN	33	31
RIJEKA EXPRESS	38	
RIMBA KERVING	6	
RIO ESQUEL	40	55
RIO FRIO	40	
RIO GRANDE	1	
RIO LIMAY	30	
ROBERT CONRAD	177	156
ROBERT E. LEE	19	40
ROGER BLOUGH		153
ROGER R. SIMONS	7	
ROSETTA	57	71
ROSINA TOPIC	85	71
ROTTERDAM	85	
ROVER	27	124
ROYAL PRINCESS	123	
ROYAL VIKING SKY	8	
RUTH LYKES	24	72
S.A. MORGENSTER	2	
S.T. CRAPO		146
SAINT LAURENT	2	
SAM HOUSTON	20	32
SAM LAUD		3
SAMOAN REEFER	87	187
SAMRAT ASHOK	18	
SAN MARTIN I	65	
SAN MATEO VICTORY	1	19
SAN MIGUEL BAY	45	
SANKO CORAL	15	
SANKO DAFFODIL	1	
SANKO DIGNITY	12	
SANKO HAWK	10	
SANKO PEACE	9	
SANKO PRELUDE	57	75
SANKO TOPAZ	4	
SANSIMENA II	48	92
SANTA ADELA	46	37
SANTA CRUZ II	27	
SANTA JUANA	89	228
SATURN DIAMOND	33	227
SAUDI DIRIYAH	43	
SAUDI HOFUF	35	
SAUDI MAKKAH	3	
SAUDI RIYADH	23	
SAUDI TABUK	54	
SAVANNAH	41	
SAVANNAH MARU	2	
SCANDINAVIAN HIGHWAY	108	
SCARAB	3	22
SEA BELLS	16	56
SEA DIAMOND	47	100
SEA FAN	31	142
SEA FORTUNE	42	84
SEA FOX	4	45
SEA JADE	22	
SEA LANTERN	52	136

Ship Name	radio	mail
SEA LION	142	309
SEA TRADE	19	
SEA TRANSPORTER	64	
SEA WOLF	88	185
SEAGRAND ACE		180
SEAHAWK	27	42
SEALAND ANCHORAGE	27	99
SEALAND ATLANTIC	40	100
SEALAND CHALLENGER	18	72
SEALAND COMMITMENT	62	109
SEALAND CRUSADER	36	79
SEALAND DEFENDER	54	155
SEALAND DEVELOPER	35	82
SEALAND DISCOVERY	59	161
SEALAND ENDURANCE	49	153
SEALAND ENTERPRISE	75	230
SEALAND EXPLORER	60	154
SEALAND EXPRESS	64	26
SEALAND FREEDOM	99	132
SEALAND HAWAII	80	252
SEALAND INDEPENDENCE	61	142
SEALAND INNOVATOR	56	119
SEALAND KODIAK	28	41
SEALAND LIBERATOR	71	98
SEALAND MARINER	81	217
SEALAND MARKETER	42	99
SEALAND NAVIGATOR	77	251
SEALAND PACIFIC	80	214
SEALAND PATRIOT	51	110
SEALAND PERFORMANCE	47	167
SEALAND QUALITY	37	152
SEALAND TACOMA	27	99
SEALAND TRADER	107	231
SEALAND VOYAGER	100	88
SEAWARD BAY	11	
SEDCO/BP 471	93	116
SENATOR		80
SEVEN OCEAN	55	41
SGT WILLIAM A BUTTON		2
SGT. METEJ KOCAK	10	
SHELDON LYKES	97	
SHENANDOAH	12	14
SHIN BEISHU MARU	52	
SHINKASHU MARU	83	
SIERRA MADRE	11	
SILVER CLIPPER	18	
SILVER STAR	15	
SILVER VICTORY	48	127
SIOUX TATE	61	
SKANDERBORG	17	
SKAUBORD	65	128
SKAUGRAN	101	68
SKEENA	153	
SKRIM	49	
SOLAR	13	9
SOLAR WING	77	178
SOMBAI	29	
SONORA	98	164
SOPHIA	60	
SOREN TOUBRO	14	49
SOUTHERN ACCORD	1	
SOUTHWARD	48	60
SPIRIT OF TEXAS	13	78
SPRING BEAR	54	
SPRING BIRD	12	
SPRING DELIGHT	1	
SPRING VEGA	40	31
ST EMILION	9	16
ST. CLAIR		133
STAR EAGLE		45
STAR EUVIVA	25	59
STAR FLORIDA	51	
STAR GEIRANGER	5	5
STAR GRAN	64	114
STAR HONGKONG	131	
STAR OF TEXAS	20	
STEWART J. CORT		201
STONEWALL JACKSON	13	20
STRATHCONON	135	
STRIDER ISIS	48	181
STUTTGART EXPRESS	76	
SUE LYKES	11	34
SUGAR ISLANDER	39	68
SUN PRINCESS	117	
SUNBELT DIXIE	177	222
SUNNY SUPERIOR	12	201
SUSAK	9	
SWIFT TRADER	72	
SWIFTNES	38	122
TABASCO	75	62
TAI CORN	25	30
TARGET	78	67
TERESA O.	1	96
TEXACO NEW YORK	53	34
THOMAS WASHINGTON	127	243
THOMPSON LYKES	30	68
TOHBEI MARU	23	
TOKYO MARU	78	
TOKYO RAINBOW	26	
TOLUCA	18	90
TONCI TOPIC	32	134
TOMSIMA	44	119
TOWER BRIDGE	93	
TROPIC SUN	18	134
TROPICALE	38	94
TRUDY	39	
TULSIDAS	48	
ULTRAMAR		35
ULTRASEA	12	49
UMAMOKTE	29	17
UNIVERSE	19	
URTE	57	91
USCGC ACTIVE WMEC 618	1	69
USCGC ALERT (WMEC 630)	1	
USCGC BASSWOOD (WLB 38	30	
USCGC BISCAYNE BAY	2	9
USCGC BOUTWELL WMEC 71	35	
USCGC BUTTONWOOD WLB 3	23	
USCGC CHEROKEE WMEC 16	19	
USCGC CITRUS (WMEC 300	104	
USCGC CLOVER (WMEC 292	48	
USCGC CONIFIR(WLB 301)	5	
USCGC DEPENDABLE	2	
USCGC ESCANABA	5	
USCGC ESCAPE (WMEC 6)		5
USCGC HARRIET LANE	1	
USCGC HUDSON (WLIC 801	1	
USCGC IRONWOOD (WLB 29	40	
USCGC JARVIS (WMEC 725	83	37
USCGC KATMAI BAY	12	18
USCGC MACKINAW	45	285
USCGC MALLOW (WLB 396)	20	
USCGC MORGENTHAU	2	
USCGC MUAH BAY	2	
USCGC NORTHLAND WMEC 9	37	
USCGC NORTHWIND WAGB 2	70	115
USCGC PLANETREE	6	3
USCGC POLAR SEA WAGB 1	204	32
USCGC POLAR STAR WAGB	268	361
USCGC RESOLUTE WMEC 62	49	
USCGC RUSH (WMEC 723)	2	
USCGC SALVIA (WLB 400)	13	
USCGC SEDGE (WLB 402)	24	34
USCGC SPENCER	8	
USCGC STEADFAST WMEC 6	46	
USCGC STORIS (WMEC 38)	29	32
USCGC SWEETBRIER WLB 4	5	
USCGC TAHOMA	7	
USCGC TAMAROA (WMEC 16	4	
USCGC TAMPA WMEC 902	7	
USCGC VALIANT (WMEC 62	1	
USCGC VENTUROUS WMEC 6	5	
USCGC VIGILANT WMEC 61	9	
USCGC VIGOROUS WMEC 62	3	
USCGC YOCONA (WMEC 168	78	104
USNS ALGOL	32	
USNS ALTAIR	14	
USNS APACHE (T-ATF 172	10	12
USNS BARTLETT(T-AGOR 1	18	
USNS CAPELLA	3	
USNS CATAWBA	3	3
USNS CHAUVENET	31	
USNS DENEBOLA	14	
USNS GUS W. DARNELL	52	
USNS HARKNESS (T-AGS 3	4	
USNS JOSHUA HUMPREYS	41	160
USNS KANE TAGS 27	89	80
USNS KAWISHIWI	1	
USNS KILAUEA		69
USNS MERCURY	48	80
USNS MISSISSINEWA		44
USNS MOHAWK (T-ATF 170	13	
USNS NARRAGANSETT	176	253
USNS NAVAJO	4	
USNS PASSUMPSIC TAO 10		47
USNS PAUCATUCK TAO-108		122
USNS POLLUX	4	
USNS POWHATAN TATF 166	3	4
USNS RANGE SENTINEL		13
USNS RIGEL (T-AF 58)		104
USNS SATURN T-AFS-10		113
USNS SEALIFT ANTARCTIC	9	
USNS SEALIFT ARABIAN S	86	176
USNS SEALIFT ARCTIC	19	11
USNS SEALIFT ATLANTIC	48	61
USNS SEALIFT CARIBBEAN	40	49
USNS SEALIFT CHINA SEA	19	15
USNS SEALIFT IND'N OCE	61	61
USNS SEALIFT MED	19	54
USNS SEALIFT PACIFIC	13	10
USNS SILAS BENT T-AGS	4	
USNS SIRIUS (T-AFS 8)		127
USNS SPICA (T-AFS 9)		9
USNS VANGUARD TAG 194	20	141
VALLEY FORGE	58	143
VAN HAWK	17	
VAN TRADER	34	58
VERRAZANO BRIDGE	119	84
VIRGO	31	194
VISHVA PALLAV	6	
VISHVA SHAKTI	6	
VISHVA SIDDHI	1	
WASHINGTON HIGHWAY	222	65
WASHINGTON RAINBOW *2	6	
WECONA		10
WESER EXPRESS	56	
WESTWARD VENTURE	159	161
WESTWOOD ANETTE	110	81
WESTWOOD BELINDA		13
WESTWOOD CLEO		48
WESTWOOD JAGO	137	116
WESTWOOD MARIANNE	30	42
WESTWOOD MERIT	18	36
WESTWOOD MUSKETEER	44	65
WILFRED SYKES	133	319
WILLIAM E. MUSSMAN		34
WILLIAM J. DELANCEY		316
WILLIAM R. ROESCH		145
WILLOWBANK	1	
WINTER STAR	20	23
WINTER SUN	21	31
WINTER WATER	10	
WINTER WAVE	35	64
WOLVERINE		133
WORLD WING *2	68	39
YACU WASI	17	57
YAMATAKA MARU	47	
YANKEE CLIPPER	30	
YORKTOWN SEA	8	27
YOUNG SCOPE	75	
YOUNG SOLDIER	23	
YOUNG SPROUT	48	103
YS ARGOSY	11	
ZEELANDIA	68	
ZEUS	3	
ZIM GENOVA	57	
ZIM HAIFA	45	
ZIM HONGKONG	42	
ZIM HOUSTON	26	
ZIM IBERIA	85	
ZIM KEELUNG	23	
ZIM MARSEILLES	6	
ZIM MIAMI	16	
ZIM NEW YORK	55	
ZIM SAVANNAH	32	
ZIM TOKYO	66	

SUMMARY:

GRAND TOTAL VIA RADIO 49589

GRAND TOTAL VIA MAIL 64104

TOTAL UNIQUE OBS 91299

TOTAL DUPLICATES 22394 (24.5%)

UNIQUE RADIO OBS.27195 (29.8%)

Top Ships

Radio	Mail
McArthur	*T. Crowell*
Moana Pacific	*Belle River*

October, November and December 1988

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
A3BE	7	7	0	***
A3BG	6	6	0	***
A3BZ	24	24	0	***
A8VI	47	47	0	PACDUCHESS
CBVM	17	17	0	VINA DEL MAR
CGBS	137	9	128	PARIZEAU
CGBU	277	0	277	DAWSON
CGBY	6	6	0	***
CGCL	75	0	75	BAFFIN
CGDG	1	1	0	HUDSON
CGDU	9	9	0	M. TEMPLEMAN
CGGTW	49	49	0	***
CG2959	1	1	0	LEONARD J. COWLEY
CXFM	18	18	0	PRESIDENTE RIVERA
C7C	182	1	181	OCEAN STATION CHARLIE
C7L	128	128	0	OCEAN STATION LIMA
DAKE	150	150	0	KOELN ATLANTIC
DA9100	173	173	0	***
DBLK	23	23	0	POLARSTERN
DGLM	50	50	0	MONTE ROSA
DGSR	12	12	0	COLUMBUS CANADA
DGUK	39	39	0	COLUMBUS VICTORIA
DGZU	40	40	0	COLUMBUS VIRGINIA
DHCW	76	76	0	COLUMBUS WELLINGTON
DHJU	85	85	0	ACT 9
DHOU	41	41	0	PURITAN
DLEZ	18	18	0	YANKEE CLIPPER
DRHB	1	1	0	***
DSMD	37	37	0	SAINT LUCIA
DSME	1	1	0	MT CABRITE
DSMZ	57	57	0	POLYNESIA
ELBX3	45	45	0	PACKING
ELDM8	43	43	0	SEAL ISLAND
ELDW8	5	5	0	SKRIM
ELED8	13	13	0	PACPRINCESS
EREA	75	68	7	MUSSON
EREB	140	116	24	VOLNA
EREC	105	2	103	PRILIV
EREH	20	0	20	PRIBOY
EREI	210	11	199	OKEAN
ERES	51	43	8	VICTOR BUGAEV
ERET	95	86	9	GEORGE OUSHAKOV
EREU	46	45	1	ERNST KRENKEL
ESGG	102	6	96	VYACHESLAV FROLOV
ETEI	1	1	0	***
FNGB	12	12	0	MARION DUFRESNE
FNGS	135	135	0	LA FAYETTE
FNJT	27	27	0	KORRIGAN
FNMZ	18	18	0	CORIOLIS
FNOM	23	23	0	ANGO
FNPA	33	33	0	RONSARD
FNQB	42	42	0	ILE MAURICE
FNQM	43	43	0	VILLE DE MARSEILLE
FNZO	24	24	0	RIMBAUD
FNZP	34	34	0	CUZCO
FNZQ	34	34	0	***
GACA	25	25	0	***
GOVL	27	27	0	ACT4
GOVN	29	29	0	ACT6
GPHN	12	12	0	FARNELLA
GXVY	28	28	0	AUSTRALIA STAR
GYAU	20	20	0	ENCOUNTER BAY
GYSA	35	35	0	FLINDERS BAY
GYSE	37	37	0	BOTANY BAY
GZIT	1	1	0	***
GZKA	26	26	0	ACT3
HCGT	2	2	0	BUCCANEER
HPAN	8	8	0	MICRONESIAN COMMERCE
HPEU	35	35	0	PACIFIC ISLANDER
H8DY	28	28	0	CAP ANAMUR
H9BQ	21	21	0	MICRONESIAN INDEPENDANCE
JASQ	13	13	0	HIYOSHI MARU
JBOA	72	72	0	KEIFU MARU
JBRA	30	30	0	JAPAN TUNA II
JCCX	59	59	0	CHOFU MARU
JCDT	53	53	0	AMERICA MARU
JCIH	51	51	0	TOKYO MARU
JCOD	87	87	0	SHOYO
JDRD	1	1	0	SHOYU MARU
JDUX	78	78	0	***
JFCI	50	50	0	***
JFDG	90	90	0	SHUMPU MARU
JGDU	23	23	0	KEITEN MARU
JGZK	130	130	0	AYOFU MARU
JJZC	26	26	0	HAKONE MARU
JMTO	10	10	0	***
JMUF	34	34	0	KAIYO MARU

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
JPJX	44	44	0	HAKURYU MARU
JPVB	106	106	0	SEIFU MARU
JQUW	17	17	0	HIDAKA MARU
JSUY	14	14	0	SHIRASE
KGWU	8	8	0	TH. WASHINGTON
KIAH	12	12	0	SEA LAND T.
KMBD	15	15	0	DELAWARE II
LOPD	19	19	0	***
NAQD	4	4	0	JARVIS
NAVOCE	49	49	0	***
NBMO	24	24	0	***
NBTH	46	46	0	POLAR STAR
NDWA	9	9	0	MORGENTHAU
NFKQ	52	52	0	SEALIFT ARABIAN SEA
NHNC	4	4	0	H. LANE
NIKA	4	4	0	SEALIFT ATLANTIC
NIKL	9	9	0	TAMPA
NLUS	42	42	0	RUSH
NOCF	187	187	0	***
NQST	95	95	0	SEALIFT ARCTIC
NRFJ	28	28	0	NORTHWIND
NRUO	33	33	0	POLAR SEA
OUEQ	1	1	0	MC KINNEY MAERSK
OUEQ2	6	6	0	***
OXFB	2	2	0	LEXA MAERSK
OXFB2	13	13	0	***
OXMD	3	3	0	LARS MAERSK
OXMD2	20	20	0	***
PGDF	44	44	0	MEDLLOYD KATWYJK
PGDG	59	59	0	MEDLLOYD KINGSTON
PGDS	47	47	0	MEDLLOYD KYOTO
PGDT	11	11	0	MEDLLOYD BALTIMORE
PGOF	31	31	0	MEDLLOYD KEMBLA
PJVG	45	45	0	OLEANDER
P3EU	7	7	0	***
SEPI	6	0	6	***
SHIP	459	459	0	***
TEST	4	4	0	***
TFER	48	48	0	BJARNI SAEMUNDSSON
TFJA	7	7	0	ARNI FRIDRIKSSON
UBMZ	29	29	0	SHULEYKIN AKADEMIK
UEAK	62	0	62	VALERIAN URVUAVEU
UFJM	128	2	126	***
UFVM	86	4	82	KAPITAN SHAYTANOV
UHQS	148	6	142	AKADEMIK KOROLEV
UJFO	77	77	0	MULTANOVSKIY PROF
UMAV	11	0	11	AKADEMIK SHIRSHOV
UMUZ	4	4	0	MIAMY
UPUI	25	25	0	PROFESSOR VIZE
UQVC	9	9	0	AKADEMIK FEDOROV
URVM	4	0	4	RUDOLF SAMOILOVICH
UUPB	288	36	252	AKADEMIK M. SHOKALSKIY
UUQR	5	5	0	MOLCHANOV PAVEL PRO
UURB	1	0	1	PAMIR
UUNJ	4	4	0	USEVOLOD BERVOZKIN
UUEC	138	18	120	PROFESSOR KHROMOV
UZCB	4	3	1	***
UZDU	4	4	0	***
UZGH	67	65	2	PASSAT
VCBT	21	21	0	CAPE ROGER
VCTF	23	23	0	CAPE BRIER
VC9450	3	3	0	GADUS ATLANTICA
VJBQ	18	18	0	AMRO AUSTRALIA
VJJF	11	11	0	***
VKCK	35	35	0	STUART
VKCM	23	23	0	CANBERRA
VKCU	33	33	0	DERWENT
VKDA	46	46	0	DARWIN
VKLC	57	57	0	BRISBANE
VKMK	39	39	0	***
VKMM	22	22	0	TEALE
VKMS	41	41	0	COOK
VLMB	55	55	0	TORRENS
VMAP	80	80	0	AUSTRALIAN PROGRESS
VXMB	40	40	0	AIRCRAFT
WCGM	6	6	0	CHEVRON CALIFORNIA
WECB	41	41	0	MELVILLE
WHBA	28	28	0	R.D. CONRAD
WHUF	67	67	0	ALBATROSS IV
WPEU	1	1	0	***
WRA4560	13	13	0	BOLD VENTURE
WRBA	2	2	0	***
WRBB	7	7	0	***
WSD3628	3	3	0	***
WSE3385	1	1	0	GLORITA
WTDF	27	27	0	T. CROMWELL

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
WTDK	171	171	0	D.S. JORDAN
WTDM	21	21	0	M.FREEMAN
WTDO	70	70	0	OREGON II
WTEA	24	24	0	DISCOVERER
WTED	34	34	0	CHAPMAN
WTEF	1	1	0	RAINIER
WTEG	12	12	0	MOUNT MITCHELL
WTEJ	201	201	0	MCARTHUR
WTEK	26	26	0	DAVIDSON
WTEP	144	144	0	OCEANOGRAPHER
WTES	42	42	0	SURVEYOR
WTE2	26	26	0	FERREL
WXBR	29	29	0	CHEVRON MISSISSIPPI
WXQ7334	9	9	0	PETER ANDERSON
WYR4481	59	59	0	W.J. DELANCEY
WYR7512	1	1	0	BALD EAGLE
WYU6568	6	6	0	DEFIANCE

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
WZE39	16	16	0	MOANA WAVE
ZCSK	68	68	0	SKEENA
ZCSL	39	39	0	NIMOS
ZMFS	6	6	0	***
3BBA	31	31	0	***
3ECT5	6	6	0	SHEARWATER
3EIX2	25	25	0	PRESIDENTE IBANEZ
3EZG5	29	29	0	HIKAWA II
3FNI2	84	84	0	MOANA PACIFIC
5MCB	1	1	0	PACMERCHANT
7JDU	5	5	0	***
7JOB	25	25	0	SHINKASHU MARU
7KDO	16	16	0	YOKO MARU
9UUU	8	8	0	AHRO ASIA

TOTAL BATHYS	RECEIVED	7073
TOTAL TESACS	RECEIVED	1937
TOTAL REPORTS	RECEIVED	9010

October, November and December 1988

Wave observations are taken each hour during a 20–minute averaging period, with a sample taken every 0.67 seconds. The significant wave height is defined as the average height of the highest one–third of the waves during the hourly averaging period. The maximum significant wave height is the highest of those values for that month. At most stations, air temperature, water temperature, wind speed and direction are sampled once per second during an 8.0–minute averaging period each hour (moored buoys) and a 2.0–minute averaging period for fixed stations (C–MAN). Contact NDBC Data Systems Division, Bldg 1100, SSC, Mississippi 39529 or phone (601) 688–2838 for more details.

STATION	LAT	LONG	OBS	MEAN AIR TP	MEAN SEA TP	MEAN SIG WAVE HT	MAX SIG WAVE HT	MAX SIG WAVE HT	SCALAR MEAN WIND SPEED	PREV WIND	MAX WIND	MAX WIND	MEAN PRESS
OCTOBER 1988													
BUOY				(C)	(C)	(M)	(M)	(DA/HR)	(KNOTS)	(DIR)	(KTS)	(DA/HR)	(MB)
32302	18.0S	085.1W	0736	17.0	17.8	2.3	3.8	05/17	14.0	SE	21.4	02/08	1017.7
41001	34.9N	072.9W	0742	20.5	24.3	1.8	4.3	08/18	13.4	N	32.5	22/05	1017.3
41002	32.2N	075.3W	0703	22.8	25.2	1.8	4.3	08/05	12.3	NE	27.9	08/03	1018.0
41006	29.3N	077.4W	0742	24.6	26.3	1.8	4.1	08/09	11.6	NE	21.4	08/01	1017.0
41008	30.7N	081.1W	0741	21.4	23.7	1.1	2.5	07/10	11.4	NE	27.0	03/19	1018.3
41009	28.5N	080.2W	1476	24.1	26.6	1.5	3.3	08/20	11.7	NE	26.8	07/20	1017.8
42001	25.9N	089.7W	0743	25.3	27.2	0.9	3.4	07/08	9.4	E	19.4	31/04	1017.7
42002	26.0N	093.5W	0739	25.1	26.7	1.0	2.8	05/15	10.0	NE	22.0	05/06	1017.8
42003	25.9N	085.9W	0744	25.4	28.0	0.9	2.8	06/23	10.8	NE	24.3	07/01	1017.2
42007	30.1N	088.8W	0744	20.9	23.5	0.4	1.2	06/04	10.9	NE	32.3	02/13	1019.6
42016	30.2N	088.1W	0743	20.8	22.9	0.4	1.0	01/06	10.3	NE	24.7	05/00	
44004	38.5N	070.6W	0744	17.3	21.4	2.0	6.5	08/09	13.1	NW	35.5	08/09	1017.8
44005	42.7N	068.6W	0743	10.5	11.7	1.9	6.2	22/16	13.4	SW	38.1	22/15	1017.9
44007	43.5N	070.1W	0735	9.1	10.8	1.1	6.9	22/19	13.9	SW	42.7	22/14	1016.2
44008	40.5N	069.5W	0738	12.6	13.7	1.8	6.4	08/19	14.5	W	36.7	08/16	1017.2
44009	38.5N	074.6W	0741	13.6	16.8	1.1	3.3	08/14	14.9	NW	29.7	08/07	1018.1
44011	41.1N	066.6W	0742	12.2	12.4	2.1	8.9	08/22	10.5	NW	33.7	08/15	1017.7
44012	38.8N	074.6W	0722	13.4	16.3	1.0	2.8	22/09	14.2	NW	31.3	23/01	1018.3
44013	42.4N	070.8W	0743	10.0	11.4	0.9	4.6	22/14					1017.1
45001	47.6N	087.1W	0744	5.8		1.2	4.7	28/16	12.0	NW	30.7	28/13	1015.0
45002	45.3N	086.4W	0742	8.3	12.5	1.1	4.8	27/23	16.3	NW	34.8	28/11	1015.0
45003	45.3N	082.8W	0742	7.8	10.5	1.1	3.6	28/04	15.3	S	32.6	29/00	1014.5
45004	47.6N	086.5W	0744	5.7	7.5	1.2	5.5	28/18	14.2	N	33.6	28/17	1013.7
45005	41.7N	082.4W	0744	9.8	13.5	0.7	2.2	24/21	14.1	NW	29.7	24/21	1017.0
45006	47.3N	089.9W	0741	5.7	7.5	0.8	3.0	28/09	11.2	SW	28.6	28/07	1015.6
45007	42.7N	087.1W	0722	9.5	13.4	1.3	3.9	05/03	15.5	NW	31.9	28/04	1016.9
45008	44.3N	082.4W	0563	9.8	13.0	1.1	3.2	11/08	13.9	NW	31.9	18/08	1014.8
46001	56.3N	148.3W	0741	8.2	9.4	2.8	6.6	28/18	13.6	W	31.2	28/16	1003.2
46002	42.5N	130.4W	0744	16.5	17.3	2.0	4.2	07/12	10.1	S	24.6	07/04	1019.3
46003	51.9N	155.9W	0739	8.2	8.0	2.9	8.1	22/12	16.4	W	31.4	22/09	1004.1
46005	46.1N	131.0W	0248	14.5	15.1	2.3	4.3	07/09	11.1	S	23.1	30/00	1017.3
46006	40.8N	137.6W	0742	16.9	17.6	2.3	5.5	13/05	14.2	S	31.9	13/02	1017.6
46010	46.2N	124.2W	0743	12.5	12.4	1.7	3.5	24/20	10.6	S	26.0	15/01	1018.1
46011	34.9N	120.9W	0741	14.2	15.0	1.5	3.3	08/19	8.4	NW	24.7	10/22	1016.7
46012	37.4N	122.7W	0744	12.9	13.6	1.3	2.5	01/03	7.5	N	22.0	13/21	1017.8
46013	38.2N	123.3W	0744	12.4	12.9	1.6	3.0	01/01	9.3	NW	28.8	19/00	1017.0
46022	40.8N	124.5W	0719	12.0	12.3				7.2	N	25.3	13/13	1018.2
46023	34.3N	120.7W	0744	14.9	15.2	1.6	3.1	01/07	11.4	NW	27.6	11/06	1015.7
46025	33.7N	119.1W	0743	17.4	18.9	0.7	1.4	11/11	5.4	W	16.7	14/23	1015.1
46026	37.8N	122.7W	0364	12.7	13.6	1.0	1.8	20/02	6.9	W	24.1	19/23	1015.6
46027	41.8N	124.4W	0739	11.6	11.5				6.5	N	25.6	17/02	1018.6
46028	35.8N	121.9W	0743	13.8	14.6	1.4	2.4	01/01	8.0	NW	24.3	11/05	1016.6
46030	40.4N	124.5W	0742	11.7	11.1	1.6	3.1	24/23	10.6	N	25.8	13/20	1017.1
46035	57.0N	177.7W	0738	5.3	6.9	2.4	7.1	26/11	15.7	NE	34.0	26/12	1006.0
46039	48.2N	123.4W	0714	10.4									1018.9
46040	44.8N	124.3W	0740	12.2	12.4	1.8	3.7	24/20	9.7	N	22.2	27/02	1018.9
46041	47.4N	124.5W	0743	11.6	12.6	1.8	3.7	24/23	6.3	N	21.4	30/05	1018.2
46042	36.8N	122.4W	0712	13.0	13.6	1.5	3.3	01/12	6.6	NW	21.4	19/22	1016.3
51001	23.4N	162.3W	0744	25.8	27.2	2.0	3.8	16/16	10.1	E	20.9	15/19	1015.5
51002	17.2N	157.8W	0741	26.0	27.2	1.8	2.9	07/13	12.5	E	22.5	07/17	1013.6
51003	19.2N	160.8W	0742	26.8	27.9	1.8	3.3	08/06	9.7	E	19.1	27/01	1013.0
51004	17.5N	152.6W	0740	26.1	26.9	1.9	3.3	07/05	11.7	E	22.4	14/12	1013.9
C-MAN													
ALSN6	40.5N	073.8W	0723	11.6	14.6				15.2	NW	43.1	21/23	1017.6
BURL1	28.9N	089.4W	0744	22.6					10.9	N	28.4	05/02	1018.3
BUZM3	41.4N	071.0W	0743	11.4					17.6	SW	58.8	22/08	1017.0
CAR03	43.3N	124.4W	0744	12.1					6.6	N	23.0	26/22	1019.0
CHLV2	36.9N	075.7W	0680	14.8	17.6	1.0	2.6	04/15	14.1	N	34.5	04/13	1019.6
CLKM7	34.6N	076.5W	0740	17.2					10.9	N	26.7	07/20	1018.8
CSBF1	29.7N	085.4W	0744	20.5					6.0	NE	18.2	03/11	1019.2
DBLM6	42.5N	079.4W	0718	9.2					11.2	S	39.1	28/16	1016.0
DESW1	47.7N	124.5W	0742	11.8					8.8	SE	31.0	13/11	1018.4
DISW3	47.1N	090.7W	0741	5.9					13.6	W	39.9	28/05	1015.8
DPIA1	30.3N	088.1W	0740	21.0	22.6				10.3	N	26.1	04/22	1019.9
DSLN7	35.2N	075.3W	0743	18.4	24.0				15.3	N	39.2	22/00	1018.7
FARP2	8.6N	144.6E	0142	27.7					8.6	E	18.2	31/04	1006.7
FBIS1	32.7N	079.9W	0742	17.7					8.6	NE	22.0	08/03	1019.9
FFIA2	57.3N	133.6W	0743	8.1					12.2	SE	33.2	08/12	1012.4
FPSN7	33.5N	077.6W	0743	19.6	22.3				15.5	N	35.7	07/22	1019.3
GDIL1	29.3N	090.0W	0743	21.5	22.9				9.6	NE	22.8	04/03	1018.4
GLLN6	43.9N	076.4W	0688	9.2					15.0	NE	38.1	18/14	1015.5
IOSN3	43.0N	070.6W	0743	9.3					14.9	W	42.4	22/15	1017.8
LKWF1	26.6N	080.0W	0738	25.4	27.0				10.0	E	22.0	06/23	1016.1
MDRM1	44.0N	068.1W	0741	8.5					17.4	SW	52.1	22/16	1016.4
MISM1	43.8N	068.9W	0740	8.7					17.3	SW	54.1	22/16	1017.1
MLRF1	25.0N	080.4W	0744	26.2	28.0				11.3	E	22.9	14/05	1015.8
MPCL1	29.4N	088.6W	0649	22.6	25.0				8.9	NE	14.7	31/13	1019.3
NWP03	44.6N	124.1W	0743	12.0					6.0	N	21.0	14/02	1019.0
PILM4	48.2N	088.4W	0659	4.8					14.8	NW	37.4	28/15	1010.9
PTAC1	39.0N	123.7W	0744	11.4					7.2	N	26.0	13/20	1017.0
PTAT2	27.8N	097.1W	0741	24.5					10.9	SE	29.0	31/16	1018.1
PTGC1	34.6N	120.7W	0744	14.1					10.9	N	28.0	22/09	1016.5
ROAM4	47.9N	089.3W	0386	3.7	8.0				17.0	NW	39.7	28/10	1010.8
SAUF1	29.9N	081.3W	0739	21.6	23.6				11.0	N	28.1	07/18	1018.9
SBIO1	41.6N	082.8W	0743	9.4					15.4	NW	36.1	28/10	1017.7

STATION	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
C-MAN													
SGNW3	43.8N	087.7W	0742	7.4					11.8	NW	34.6	27/18	1016.6
SISW1	48.3N	122.8W	0743	10.5					3.8	W	21.0	30/06	1018.5
SMKF1	24.6N	081.1W	0721	26.0	27.5				12.1	NE	30.6	15/00	1016.2
SPGF1	26.7N	079.0W	0724	25.5	27.5				8.5	E	21.0	01/05	1016.6
SRST2	29.7N	094.1W	0739	21.1					8.7	NE	24.5	26/22	1019.2
STDM4	47.2N	087.2W	0743	6.0					17.3	N	43.1	28/17	1014.8
SVLS1	32.0N	080.7W	0741	19.2	21.9				13.9	NE	34.4	13/13	1019.2
TPLM2	38.9N	076.4W	0744	12.9	16.0				11.9	S	27.0	29/01	1019.2
TTIW1	48.4N	124.7W	0743	11.2					11.6	NE	36.1	01/16	1018.5
VENF1	27.1N	082.5W	0698	22.3	25.3				6.9	NE	18.3	07/20	1017.3
WPOW1	47.7N	122.4W	0739	12.4					7.1	N	27.6	21/20	1018.8
NOVEMBER 1988													
BUOY													
32302	18.0S	085.1W	0789	17.4	17.9	2.1	3.8	21/20	12.2	SE	18.8	22/08	1017.7
41001	34.9N	072.9W	0718	19.3	21.9	2.2	7.1	28/22	16.0	SW	32.4	24/13	1017.6
41002	32.2N	075.3W	0719	22.0	23.5	2.0	5.9	24/15	12.3	S	33.5	24/14	1018.7
41006	29.3N	077.4W	0719	23.7	25.2	1.7	5.0	24/00	11.6	SE	27.8	23/21	1017.8
41008	30.7N	081.1W	0717	19.6	20.9	1.1	2.8	23/08	11.0	NE	26.2	28/16	1017.8
41009	28.5N	080.2W	1430	23.4	25.1	1.3	4.3	23/13	11.8	SE	29.9	23/21	1018.1
41010	28.9N	078.6W	0630	24.6	25.5	1.3	3.9	23/11	10.5	SE	27.2	23/11	1019.9
42001	25.9N	089.7W	0720	24.0	25.4	1.3	4.2	22/15	12.2	SE	27.4	28/12	1016.5
42002	26.0N	093.5W	0718	23.7	25.3	1.4	3.9	20/17	13.9	S	31.1	27/23	1015.9
42003	25.9N	085.9W	0717	24.3	26.1	1.5	7.8	22/13	13.6	E	49.5	22/16	1016.4
42007	30.1N	088.8W	0718	19.3	21.1	0.7	2.0	26/18	13.1	S	28.4	28/06	1017.6
42016	30.2N	088.1W	0719	19.4	20.7	0.7	1.9	26/19	12.3	S	25.3	06/01	
44004	38.5N	070.6W	0718	14.5	16.2	2.3	7.1	28/22	15.1	NW	32.2	29/00	1017.4
44005	42.7N	068.6W	0720	8.2	9.0	2.1	5.8	02/10	14.9	W	29.4	02/09	1015.2
44007	43.5N	070.1W	0712	6.7	8.2	1.0	5.1	02/11	13.3	S	35.0	02/04	1013.5
44008	40.5N	069.5W	0719	10.4	11.3	2.0	5.9	02/18	16.1	W	40.8	21/13	1015.8
44009	38.5N	074.6W	0277	12.3	13.7	1.1	3.0	02/01	16.5	W	31.7	06/02	1012.9
44011	41.1N	066.6W	0718	10.0	10.2	2.6	7.7	22/02	13.6	NW	30.4	02/09	1015.9
44012	38.8N	074.6W	0666	11.1	12.4	1.0	3.2	21/03	15.5	NW	32.6	21/01	1017.1
44013	42.4N	070.8W	0220	9.5	9.4	0.8	3.9	02/05					1008.9
45001	47.6N	087.1W	0714	2.0	4.2	1.5	5.4	06/08	14.9	N	25.5	01/18	1009.1
45002	45.3N	086.4W	0266	5.4	7.8	1.0	4.1	01/00	14.4	NW	35.8	06/05	1005.4
45003	45.3N	082.8W	0681	5.1	6.9	1.3	4.2	16/16	16.3	S	35.4	16/15	1010.7
45004	47.6N	086.5W	0175	2.6	4.8	1.5	4.3	05/09	15.3	NE	33.4	05/09	1003.0
45005	41.7N	082.4W	0498	7.0	7.6	0.8	1.9	07/08	14.5	SW	30.7	10/13	1012.2
45006	47.3N	089.9W	0164	2.5	5.3	1.7	5.1	05/17	15.1	N	32.3	05/13	1005.6
45007	42.7N	087.1W	0717	6.0	7.6	1.3	3.8	16/17	16.0	S	34.4	17/03	1010.9
46001	56.3N	148.3W	0718	4.7	7.3	3.5	7.8	23/02	15.5	W	32.7	21/08	991.1
46002	42.5N	130.4W	0718	13.6	15.3	4.4	9.5	23/10	17.1	W	34.2	13/18	1015.4
46003	51.9N	155.9W	0506	5.9	6.2	4.1	7.5	28/15	19.3	W	34.4	22/21	999.3
46005	46.1N	131.0W	0068	13.1	13.9	4.6	6.5	03/06	18.1	W	31.1	02/06	1005.2
46006	40.8N	137.6W	0712	13.6	15.0	4.0	7.4	22/15	20.2	W	38.5	13/06	1017.6
46010	46.2N	124.2W	0717	10.3	11.4	3.6	8.3	23/14	16.5	S	43.9	02/15	1011.8
46011	34.9N	120.9W	0718	13.4	13.2	2.7	5.3	26/07	10.9	NW	27.1	18/02	1019.8
46012	37.4N	122.7W	0718	12.8	12.9	2.4	4.7	14/23	10.9	S	29.8	25/06	1020.7
46013	38.2N	123.3W	0720	12.4	12.9	2.9	6.3	23/23	10.9	NW	29.9	06/23	1019.9
46022	40.8N	124.5W	0718	11.7	12.1				11.5	S	31.8	02/23	1018.3
46023	34.3N	120.7W	0717	13.9	13.6	2.8	5.6	24/19	14.4	NW	31.4	29/01	1018.7
46025	33.7N	119.1W	0717	15.5	16.3	1.1	2.5	15/05	7.6	W	28.2	18/02	1017.6
46026	37.8N	122.7W	0718	12.4	12.7	2.0	3.6	23/22	11.7	NW	30.7	25/06	1019.6
46027	41.8N	124.4W	0717	11.4	11.7				13.5	S	36.9	16/18	
46028	35.8N	121.9W	0718	13.6	13.9				10.5	NW	24.7	27/00	1019.8
46030	40.4N	124.5W	0711	11.5	11.6	3.1	6.9	23/19	12.5	SE	34.0	25/02	1018.0
46035	57.0N	177.7W	0712	0.5	4.5	3.2	6.9	04/23	17.8	N	39.2	02/20	1002.7
46040	44.8N	124.3W	0236	11.9	12.1	3.6	8.3	02/21	13.4	NE	36.5	02/19	1012.0
46041	47.4N	124.5W	0718	9.1	11.3	3.6	9.2	23/12	12.7	SE	29.1	02/14	1010.7
46042	36.8N	122.4W	0679	12.6	13.0	2.9	5.7	24/06	8.2	NW	25.3	25/05	1019.4
51001	23.4N	162.3W	0719	25.3	25.7	2.6	12.3	05/04	13.9	E	35.3	04/09	1016.3
51002	17.2N	157.8W	0719	25.6	26.6	2.5	4.2	05/11	16.9	E	26.1	09/00	1014.5
51003	19.2N	160.8W	0715	26.3	27.1	2.3	6.6	05/01	12.8	E	23.9	04/17	1014.0
51004	17.5N	152.6W	0717	25.7	26.6	2.4	3.5	21/20	15.5	E	24.2	11/18	1015.2
C-MAN													
ALSM6	40.5N	073.8W	0711	9.4	10.5				17.0	NW	40.1	21/23	1015.9
BURL1	28.9N	089.4W	0717	21.2					14.8	SE	34.8	26/18	1016.4
BUZM3	41.4N	071.0W	0718	9.4					19.2	W	47.4	21/03	1015.0
CAAO3	43.3N	124.4W	0718	10.3					10.8	S	36.1	02/23	1016.0
CHLV2	36.9N	075.7W	0700	13.1	14.3	1.0	3.0	01/18	16.1	S	37.3	06/00	1018.6
CLKM7	34.6N	076.5W	0261	16.9					11.3	SW	24.9	07/02	1014.1
CSBF1	29.7N	085.4W	0718	19.2					7.2	NE	26.9	06/04	1018.2
DBLN6	42.5N	079.4W	0660	6.9					14.5	S	49.4	10/17	1014.0
DESW1	47.7N	124.5W	0719	8.9					15.9	SE	44.1	05/15	1010.5
DISW3	47.1N	090.7W	0713	1.5					14.5	W	40.8	17/08	1010.1
DPIA1	30.3N	088.1W	0717	19.0	20.1				12.2	SE	29.6	27/22	1017.9
DSLM7	35.2N	075.3W	0718	18.2	22.6	1.9	4.8	28/15	18.7	NE	44.8	01/14	1019.3
FARP2	8.6N	144.6E	0715	28.4					9.2	E	20.7	06/03	1008.9
FBIS1	32.7N	079.9W	0718	15.9					7.6	NE	23.0	05/15	1018.9
FFIA2	57.3N	133.6W	0719	5.1					15.5	SE	46.4	21/05	997.8
FPSM7	33.5N	077.6W	0712	19.5	24.6				18.2	N	43.4	05/15	1018.5
GDIL1	29.3N	090.0W	0717	20.0	20.7				11.3	S	29.3	27/17	1016.4
GLLN6	43.9N	076.4W	0085	7.8					19.2	SE	33.1	02/20	1005.6
IOSN3	43.0N	070.6W	0719	7.0					15.9	W	41.7	02/05	1015.2
LKWF1	26.6N	080.0W	0675	24.2	25.1				11.0	E	29.0	23/08	1016.8
MDRM1	44.0N	068.1W	0717	6.4					19.9	NW	47.1	02/11	1013.2
MISM1	43.8N	068.9W	0716	6.6					19.4	NW	44.1	02/11	1014.4
MLRF1	25.0N	080.4W	0716	25.2	26.5				16.9	E	31.7	23/11	1016.6
MPCL1	29.4N	088.6W	0716	21.1					14.8	S	32.0	06/05	1017.9
MWP03	44.6N	124.1W	0716	10.1					11.7	S	42.1	02/21	1014.6
PILM4	48.2N	088.4W	0719	1.2					15.8	N	38.1	17/06	1010.8
PTAC1	39.0N	123.7W	0719	11.1					7.7	N	22.0	07/16	1019.3
PTAT2	27.8N	097.1W	0716	21.5					14.1	S	27.7	15/20	1015.6
PTGC1	34.6N	120.7W	0717	13.0					12.9	N	36.8	18/01	1019.5
ROAM4	47.9N	089.3W	0716	1.4	4.9				18.6	N	46.1	06/14	1010.4
SAUF1	29.9N	081.3W	0712	19.8	21.8				9.3	NE	33.6	23/09	1018.7
SBIO1	41.6N	082.8W	0718	6.4					15.9	S	41.4	16/14	1013.6
SGNW3	43.8N	087.7W	0719	4.1					13.4	NW	33.8	16/13	1010.2
SISW1	48.3N	122.8W	0718	8.1					13.5	SE	41.1	19/16	1010.6
SMKF1	24.6N	081.1W	0702	25.2	25.8				16.2	E	34.8	22/16	1016.9
SPGF1	26.7N	079.0W	0685	24.3	26.1				8.9	E	19.8	25/12	1017.5
SRST2	29.7N	094.1W	0717	18.5					9.9	S	24.0	18/08	1016.5
STDM4	47.2N	087.2W	0718	2.3					19.3	N	46.1	06/07	1009.5
SVLS1	32.0N	080.7W	0718	17.5	18.6				14.2	NE	32.5	28/17	1018.3
TPLM2	38.9N	076.4W	0718	10.0	10.9				11.1	S	29.6	21/06	1017.6
TTIW1	48.4N	124.7W	0717	8.8					14.9	SE	41.1	05/17	1010.1

STATION	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
C-MAN													
VENF1	27.1N	082.5W	0716	21.3	22.9				7.3	E	33.1	23/05	1017.0
WPOW1	47.7N	122.4W	0704	8.7					11.2	S	26.3	23/04	1012.0
DECEMBER 1988													
BUOY													
32302	18.0S	085.1W	0738	18.6	18.8	1.8	3.1	01/13	10.7	SE	19.4	12/07	1016.6
41001	34.9N	072.9W	0742	15.0	20.5	2.1	6.7	14/15	16.1	NW	32.0	14/13	1020.1
41002	32.2N	075.3W	0743	18.9	23.9	1.8	4.4	14/01	13.1	NW	29.1	13/20	1022.1
41006	29.3N	077.4W	0741	20.8	24.0	1.6	4.6	13/12	10.8	NW	28.5	13/09	1021.9
41008	30.7N	081.1W	0744	14.1	16.5	0.9	3.1	12/14	9.5	N	28.0	12/23	1023.2
41009	28.5N	080.2W	1473	20.0	22.8	1.2	3.8	13/06	11.2	NW	29.0	13/05	1022.9
41010	28.9N	078.5W	1474	20.7	23.8	1.4	3.8	13/10	11.9	E	30.9	13/08	1022.4
42001	25.9N	089.7W	0742	21.7	23.6	1.1	2.9	29/01	10.5	NE	23.7	01/14	1021.8
42002	26.0N	093.5W	0741	21.1	23.2	1.3	4.3	28/17	13.2	SE	34.4	28/13	1021.3
42003	25.9N	085.9W	0741	22.0	26.1	1.2	3.8	13/03	12.7	SE	30.3	13/02	1021.8
42007	30.1N	088.8W	0739	14.0	16.5	0.6	1.7	28/13	11.7	NE	31.1	28/12	1023.7
42015	30.1N	088.2W	0412	14.5	15.5	0.7	1.6	20/14	9.6	SE	25.1	16/12	1023.2
42016	30.2N	088.1W	0335	12.5	15.9	0.4	1.1	08/21	11.3	NE	26.2	11/11	
44004	38.5N	070.6W	0742	8.9	13.2	2.5	6.2	15/04	15.5	NW	31.9	18/17	1019.3
44005	42.7N	068.6W	0742	2.5	7.0	2.1	6.2	15/06	14.6	NW	29.7	29/02	1017.3
44007	43.5N	070.1W	0738	-0.4	6.1	0.9	5.2	15/08	14.2	W	33.0	04/11	1016.2
44008	40.5N	069.5W	0727	4.7	8.2	2.0	6.0	14/23	17.3	NW	37.3	29/05	1017.8
44011	41.1N	066.6W	0743	4.5	7.3	2.6	8.9	14/21	13.9	NW	34.0	14/15	1016.9
44012	38.8N	074.6W	0694	4.7	8.5	1.0	3.3	15/06	15.5	NW	35.0	28/23	1020.7
44013	42.4N	070.8W	0556		5.9	0.8	3.8	15/06	14.7	W	34.6	16/04	1019.1
45001	47.6N	087.1W	0718	-4.5	3.7	1.7	4.4	23/06					
45007	42.7N	087.1W	0122	2.6	6.1	1.5	3.4	04/01	17.5	W	28.4	03/20	1022.9
46001	56.3N	148.3W	0743	3.9	5.5	4.3	10.6	19/12	16.8	W	33.7	07/18	1003.4
46002	42.5N	130.4W	0742	11.7	13.3	3.6	12.6	21/08	15.6	NW	35.1	27/08	1023.7
46003	51.9N	155.9W	0247	4.1	4.0	4.8	10.1	18/21	20.7	W	38.1	18/21	1003.5
46005	46.1N	131.0W	0410	8.7	10.4	4.2	11.7	21/02	17.6	NW	32.5	21/04	1019.1
46006	40.8N	137.6W	0739	12.3	13.7	3.2	9.1	30/18	17.5	S	37.9	30/13	1025.5
46010	46.2N	124.2W	0741	8.1	9.4	2.1	4.6	13/20	14.1	E	36.3	30/09	1019.9
46011	34.9N	120.9W	0742	11.8	13.0	2.2	5.9	22/06	8.0	NW	20.4	07/06	1021.2
46012	37.4N	122.7W	0742	11.3	11.8	2.2	5.9	21/22	11.1	N	39.4	15/09	1022.0
46013	38.2N	123.3W	0740	10.5	11.3	2.4	7.0	21/21	11.1	NW	31.6	15/07	1021.6
46022	40.8N	124.5W	0742	9.9	10.6	4.0	10.0	21/17	10.5	N	30.6	14/19	1021.8
46023	34.3N	120.7W	0741	12.3	12.8	2.2	6.2	22/07	11.6	NW	26.1	25/14	1020.4
46025	33.7N	119.1W	0744	14.0	14.3	1.0	2.2	09/12	9.4	NW	29.0	08/08	1019.7
46026	37.8N	122.7W	0739	10.7	11.1	1.8	4.8	22/00	12.1	NW	41.6	15/16	1021.0
46027	41.8N	124.4W	0303	11.5	10.0				8.4	N	25.8	13/14	
46028	35.8N	121.9W	0742	11.9	13.1	3.3	6.5	22/08	10.1	NW	25.7	07/03	1021.0
46030	40.4N	124.5W	0733	9.8	10.0	2.8	8.8	21/15	12.1	N	35.0	22/12	1021.2
46035	57.0N	177.7W	0723	-0.9	2.9	3.3	8.1	24/07	18.9	N	38.9	14/02	996.4
46041	47.4N	124.5W	0286	9.5	10.5	2.2	3.9	02/16	9.4	SE	19.4	01/21	1023.9
46042	36.8N	122.4W	0710	10.8	11.7	2.5	7.1	21/23	8.5	NW	27.2	24/10	1020.6
S1001	23.4N	162.3W	0743	24.2	25.4	3.0	7.2	07/16	13.2	E	28.4	06/15	1016.0
S1002	17.2N	157.8W	0741	24.7	26.0	2.5	5.5	31/20	14.8	E	31.5	19/13	1014.9
S1003	19.2N	160.8W	0740	25.3	26.5	2.6	5.6	07/17	11.6	E	26.3	18/13	1013.9
S1004	17.5N	152.6W	0741	24.6	25.6	2.6	5.4	31/16	13.8	E	27.4	31/13	1015.7
C-MAN													
ALSM6	40.5N	073.8W	0739	2.9	7.4				15.8	NW	39.1	04/10	1019.8
BURL1	28.9N	089.4W	0742	15.7					13.2	N	35.1	11/10	1022.2
BUZM3	41.4N	071.0W	0740	2.7					18.0	W	39.7	29/02	1017.8
CAMO3	43.3N	124.4W	0741	8.5					9.1	S	29.0	21/09	1022.0
CHLV2	36.9N	075.7W	0737	6.6	9.5	0.9	2.4	04/15	15.7	N	37.0	04/14	1022.6
CLKN7	34.6N	076.5W	0505	8.5					11.6	N	25.8	12/01	1023.6
CSBF1	29.7N	085.4W	0742	13.5					5.6	E	13.5	17/17	1024.1
DBLN6	42.5N	079.4W	0740	-0.1					16.4	W	39.4	23/10	1018.9
DESW1	47.7N	124.5W	0740	7.3					12.5	SE	41.1	20/19	1019.5
DISW3	47.1N	090.7W	0704	-5.5					16.2	W	36.7	23/20	1016.3
DPIA1	30.3N	088.1W	0741	13.2	14.3				11.1	N	31.0	16/11	1024.1
DSLN7	35.2N	075.3W	0742	11.5	19.7	1.5	6.1	16/15	18.0	W	37.8	28/17	1023.4
FARP2	8.6N	144.6E	0740	28.0					9.6	E	26.1	20/11	1008.8
FBIS1	32.7N	079.9W	0741	9.5					6.5	NE	22.0	12/09	1024.3
FFIA2	57.3N	133.6W	0741	2.8					14.7	SE	35.4	03/13	1015.4
FPSN7	33.5N	077.6W	0737	13.3					15.5	N	35.1	28/16	1023.6
GDIL1	29.3N	090.0W	0739	14.7	15.4				10.2	NE	30.2	11/08	1022.5
GLLN6	43.9N	076.4W	0462	-1.7					18.1	S	43.4	23/12	1017.9
IOSN3	43.0N	070.6W	0741						16.5	W	38.1	16/04	1018.2
LKWF1	26.6N	080.0W	0674	21.0	23.9				9.0	NW	22.0	20/12	1021.3
MDRM1	44.0N	068.1W	0741	-0.5					19.7	NW	38.1	26/08	1015.5
MISM1	43.8N	068.9W	0739	-0.4					19.1	NW	43.1	26/09	1017.1
NLNF1	25.0N	080.4W	0737	22.1	24.5				13.2	E	28.1	02/11	1021.0
NPCL1	29.4N	088.6W	0737	17.2					13.5	SE	33.7	11/11	1023.7
NWPO3	44.6N	124.1W	0741	7.8					8.9	E	34.1	21/07	1021.5
PILM4	48.2N	088.4W	0662	-7.4					17.3	NW	38.6	12/19	1016.1
PTAC1	39.0N	123.7W	0740	9.2					8.2	N	32.0	15/00	1021.2
PTAT2	27.8N	097.1W	0737	16.0					10.5	N	27.1	28/02	1021.9
PTGC1	34.6N	120.7W	0740	12.1					10.8	N	33.5	21/10	1021.0
ROAM4	47.9N	089.3W	0458	-5.9	3.9				19.7	N	42.6	12/13	1016.2
SAUF1	29.9N	081.3W	0724	14.4	16.7				8.6	N	37.4	13/01	1024.1
SBIO1	41.6N	082.8W	0741	-0.7					16.5	W	36.0	23/17	1019.9
SGNW3	43.8N	087.7W	0739	-3.4					12.9	W	37.4	23/03	1018.0
SISW1	48.3N	122.8W	0739	6.2					9.7	SE	37.1	13/10	1019.9
SMKF1	24.6N	081.1W	0728	21.8	23.6				14.6	E	29.9	02/11	1021.4
SPGF1	26.7N	079.0W	0643	21.4	24.3				7.6	E	22.2	13/17	1021.8
SRST2	29.7N	094.1W	0741	12.9					8.3	SE	19.8	28/07	1022.8
STDM4	47.2N	087.2W	0735	-4.1					20.0	NW	43.1	03/18	1014.9
SVLS1	32.0N	080.7W	0742	11.6	13.9				12.0	NE	33.7	12/11	1023.8
TPLN2	38.9N	076.4W	0741	3.8	5.6				11.1	NW	36.8	28/20	1021.7
TTIW1	48.4N	124.7W	0740	7.2					13.0	E	35.1	13/05	1019.6
VENF1	27.1N	082.5W	0736	16.8	18.6				6.7	NE	21.2	16/23	1022.4
WPOW1	47.7N	122.4W	0729	6.9					10.1	S	31.8	30/09	1020.9

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The Passing of an Era

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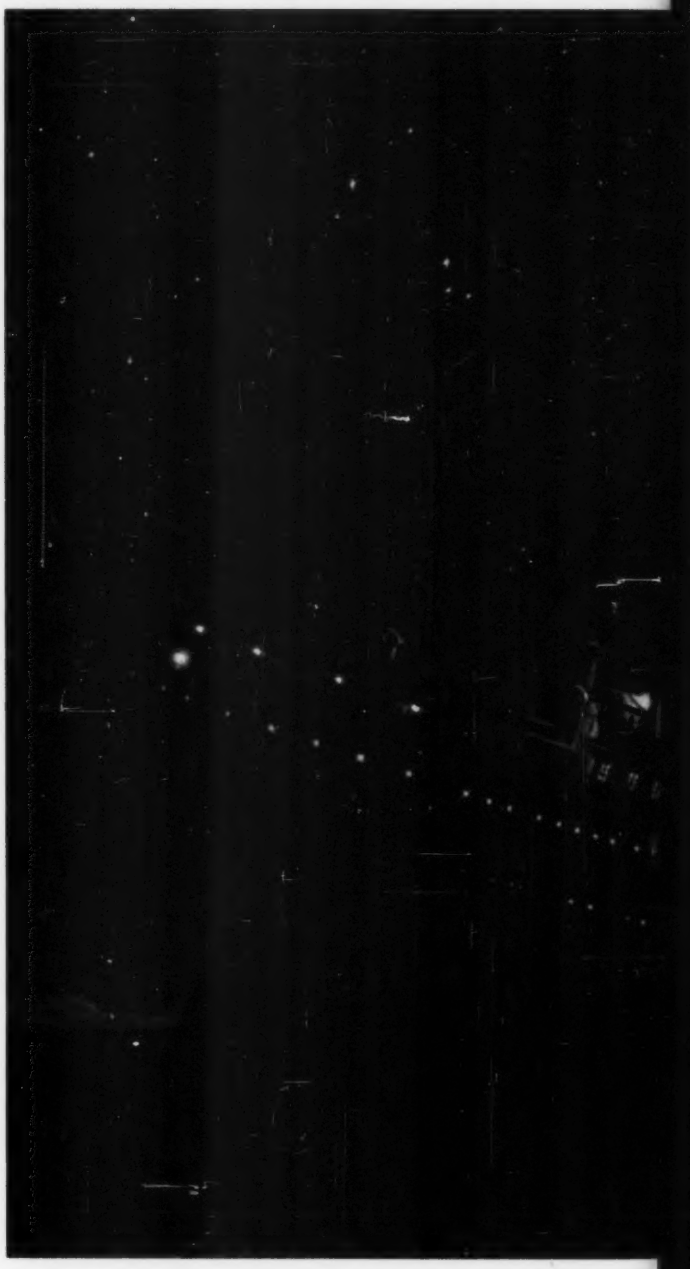

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